ENGINEERING AND MINING JOURNAL

A McGRAW-HILL PUBLICATION

DECEMBER 1959

PRICE ONE DOLLAR

FOUNDED 1866

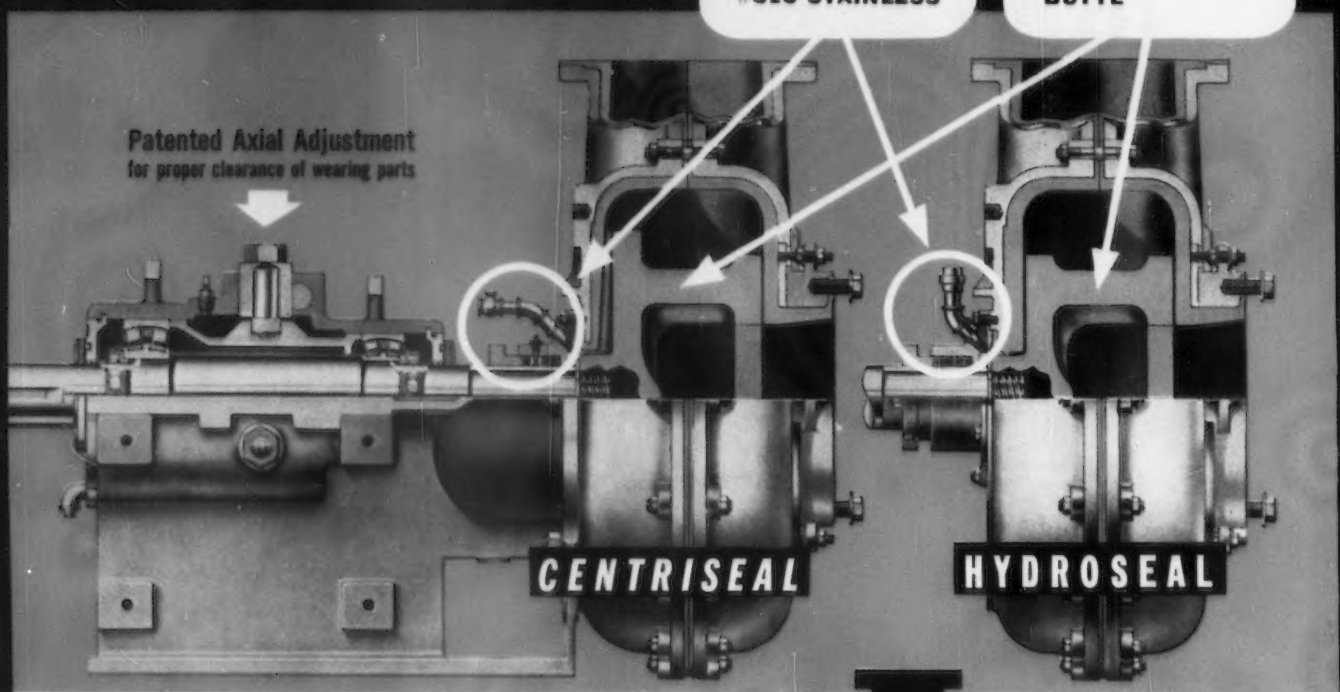
Flexibility helps A-S-H split-shell pumps lick problems in moving abrasives / corrosives

Choices for wetted parts

CARBON STEEL
and/or **CAST IRON**
HASTELLOY "C"
DURIMET 20
#316 STAINLESS

Choice of **MAXIMIX** *elastomers*

NATURAL RUBBER
ACID RUBBER
NEOPRENE
HYPALON
NITRILE
POLYURETHANE
(Cast or Molded)
VITON "A"
BUTYL



Delivers the pulp undiluted. No sealing water.

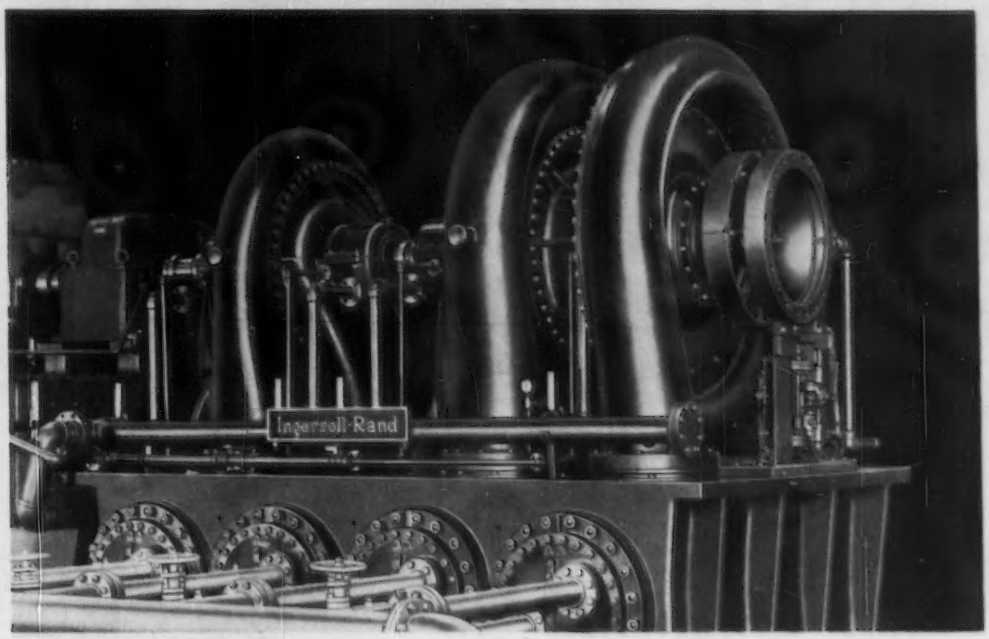
Operates with sealing water.

This diagram tells why these interchangeable pumps are proving to be so useful in mining and in both metallurgical and chemical processing. Experienced in applying the various metals and elastomers, our engineers may help you improve *your* pumping. Ask us.

THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. B—P.O. Box 635, Paoli, Pa.
Representatives throughout the World

CENTRISEAL and HYDROSEAL
SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED

ANOTHER ***NEW DEVELOPMENT*** FROM INGERSOLL-RAND



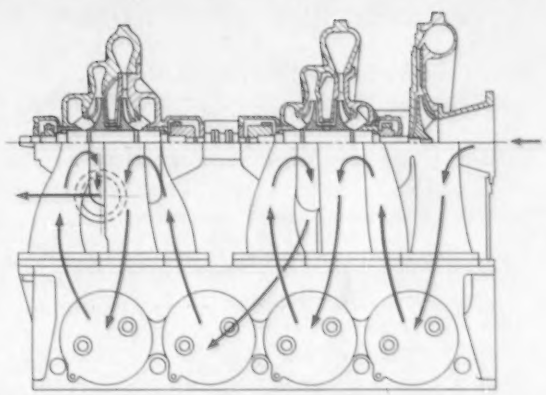
New 100 psi Centrifugal Air Compressor delivers up to 35,000* cfm

Five-Stage Intercooled Unit provides new efficiency and economy, with big savings in space and weight

THE Ingersoll-Rand CVM Centrifugal Compressor represents a new concept in the efficiency and economy of large-capacity air compression in the 100-125 psi range. With five compression stages and intercooling between each stage, it approaches the ideal *isothermal design*, delivering more air per horsepower than any other type of multi-stage centrifugal compressor.

The five impellers are mounted on two shafts, with two impeller pairs back-to-back to minimize axial thrust. The short shaft construction permits operation below first critical speed, minimizing vibration and extending the life of bearings and seals. The water-cooled intercoolers are integral with the machine base, have all water connections on the same side, and can be cleaned while the compressor is in operation.

The CVM Centrifugal Compressor is available in ratings to 35,000 cfm for discharge pressures to approximately 125 psi. For further details, see your I-R representative or write to Ingersoll-Rand.



Side elevation drawing of a CVM Centrifugal Air Compressor with top half of casing sections cut away to show impeller arrangement. Arrows indicate air flow through impellers and intercoolers.

Ingersoll-Rand

12-988 11 Broadway, New York 4, N. Y.

**Higher capacities available with other designs.*

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ENGINEERING AND MINING JOURNAL

93rd YEAR OF PUBLICATION

DECEMBER 1959

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B.F.Goodrich

Belt takes a giant step

B. F. Goodrich improvements in rubber brought extra savings

POURING up that steep grade is a never-ending stream of rock—waste from the coal preparation plant in the valley. It's carried by a conveyor belt, at the rate of 400 tons an hour, almost a third of a mile to the top of that 500-foot high ridge. Ordinarily it would take at least three or more belts to lift heavy loads like this so far. But this B.F.Goodrich belt does it in one hop—and at a terrific saving.

In this exclusive B.F.Goodrich conveyor belt design, individual steel cords run lengthwise in the belt. Each cord is completely surrounded and cushioned by rubber so that it can stand the impact of heavy loads. These parallel cords give tremendous strength, yet are flexible so that troughing is natural.

Because of its steel cord construction, the B.F.Goodrich belt can do the job of three or four belts on this high lift, long distance installation. It eliminates the transfer points necessary with a conveyor system built in several stages with ordinary belts, saving money on the original installation and in reduced maintenance costs.

This B.F.Goodrich steel cord belt has been in operation nearly two years and is expected to give many more years of service. A similar belt carrying ore on the Iron Range is in its 11th season, has lasted longer than any conveyor belt ever made with steel cords or cables.

Your B.F.Goodrich distributor has exact specifications for the B.F.Goodrich belt described here. And, as a factory-trained specialist in rubber products, he can answer your questions about the many rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Co., Dept. M-756, Akron 18, Ohio.*

B.F.Goodrich *conveyor belts*

Behind the By-Lines...

Ye Christmas Greetings

The candle pick is on page one—
We're off again. Before we're done
Let's hope our friends get word directly
(And that we've spelled their names correctly)
That all we wish for every one,
Each mother's daughter, father's son,
Is Merry Christmas, Bonne Année
From McIntyre to Mandalay.

Let those whose life is 'neath the sun
Of Moa Bay, where work's begun,
Come join with those who like the feel
Of weather north of Port Sept Iles.
Dick Colligan, meet Paul Filteau;
Dave Daquin, this is Dan Champeaux,
Al McKenzie, and Alec Tait.
Let's hope their coming year is great.

Decant the wine! Hold open house,
For Roger Pierce and Oscar Straus,
R. P. Cecatty, Ernst C. Krause,
Don Mastick and his lovely spouse,
Hank Hance, Ken Powell, K. C. Li,
—All the gang from Gañon C,
Gerry Berube, Tom Ferguson,
Heléne Tellier, Hal Kristjanson;

William Steele, Bill (Lyman) Hart,
Dan Thorn and Allen Engelhardt,
Leon Meadows, Jack DeWitte,
F. E. Essed, Charlie Mit-
ke, Casey Jones, (that's Marshall G.)
E. A. Slover, R. E. Lee
And C. Van Kooten, Surinam,
Karl Lindell, Bill Lennemann;

Robert Koenig, Kuno Doerr,
Severn Brown, Hall Carpenter,
Roger Caywood—Adrian
Dorenfeld and Jack M. Han-
ley, J. C. Keiffer of Spokane,
Mike C. Romney and his Jan.
Forgive the hyphens, Van Serg, McK.,
The rhymes just seem to come that way.

The nicest thing about this fete
Is, no one pays the piper. Just let
Each of us, before year-end,
A genial, moderate, elbow bend.

Now at this point, we'd like to play a
Carol for all at Cananea,
For John Loving, good will show,
Bob Weed and C. P. Donohoe.

Let's hope the Merry Christmas sock
Is filled with ever richer rock
For Al McLeish, George Kereghan
And Pharic D. I. Honeyman,
For Barry Bourne and H. C. Keiser,
All our friends at Moab, Weiser,
Esterhazy, Cerro, Home-
stake, Santiago, Nome.

Put all the gifts that can be put
Beneath the tree for Royal Foote,
Royale Stevens, Richard Gee,
Dr. Stuart Zimmerley,
S., and C. D. Michaelson,
Ditto Harry Radhakishun,
Howard Winn, Bob Holliday,
And Russell Haworth, PCA.

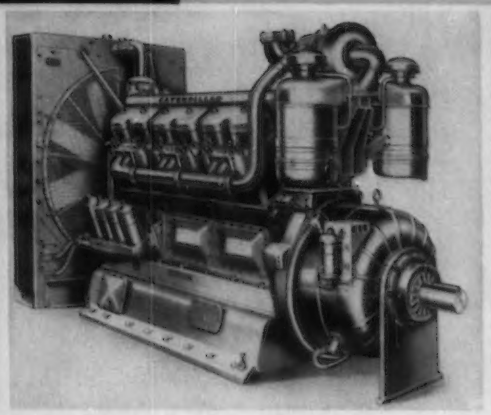
Send Christmas greeting, warm and witty
To Eddie Borcherdt and to Smitty,
To Claude E. Fertig, Philippines,
Send a thatch of Christmas greens.
We'll leave the dishes in the sink
To toast F. H. J. Dieperink,
And string the lights around the trees
For Señor Lloyd Antonides.

Rename the saint Herr Santa Clausen
So we can greet "T" Trommershausen,
And Lee Newman, Orin Norris,
Otto Vondrak, A. P. Morris.
Nordic's Cedric Anderson
And Brokopondo's Teunissen.
Applaud the clarity of the scene,
Courtesy Pudney and Kneen.

To all, at every bench and face,
Lots of high grade ore in place,
Quiet murmurs from the mill
And naught but tails going down the hill.
In the world (as well as the maintenance shop)
May everything that should stop, stop—
And everything that should go, go—
In the year of Our Lord, one-nine-six-oh. —DPE

engine power
BY CATERPILLAR

How powering your excavator with the Cat D397 (Series D) will give you an edge over competition



The dependable Cat D397 Engine for excavators—deservedly popular in coal and metal strip mining—has been proved, improved and perfected. For original power and repowering, this diesel is the leader in the field because it features a "full power" fuel system, fast governor response for sudden load changes and it's built for long working life.

A dragline is only as productive as the power plant driving it. The Cat D397 (Series D) Engine is preferred "big diesel" power because through the years it has been constantly improved. Now turbocharged, boosting output 160 HP, it has full flow filtering, and steel-backed aluminum bearings doweled in place for stability. You get higher engine quality for less.

It means volume production of parts, too, with the same high-quality, low-cost result. Parts prices should always be reckoned in terms of the original investment. With purchase of a Cat Diesel Engine comes assurance of the best service and operating help and installation counsel in the industry. In the U. S. alone, Caterpillar Dealers have 7,500 experienced servicemen and over 2,000 field service trucks on call 24 hours a day.

From 1950 to the present, Cat "V" Engines have powered the majority of big diesel excavators. Caterpillar policy of continual design improvement has resulted in over 100 major improvements in the D397 since that date. Repowering with Cat Diesels steps up production, for these power plants are free from delicate adjustments, they operate smoothly under a wide variety of loads . . . they are simple to service and easy to operate . . . they are easily started in any weather, and their dependability keeps equipment working.

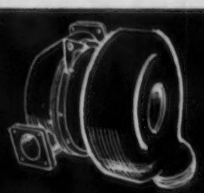
So specify a Cat "V" Engine in your next diesel powered excavator. For money-saving repowering service, call your nearby Cat Dealer.

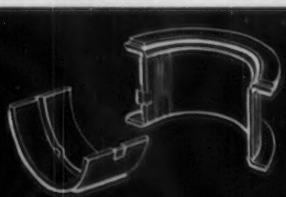
Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A. Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

Turbocharging the D397 gives higher horsepower per pound of engine weight, with operating economy and long life.

Main bearings are steel-backed aluminum alloy for better load capacity and better corrosion resistance.

Large capacity elements filter *all* the oil, give longer engine life. The elements are accessible, and easily replaced.





NO STUCK STEELS

WITH THE NEW LE ROI DUSTLESS AIR LEG DRILLS

NEW "DUSTLESS" AIR LEG drills dry, fast and clean. Cuttings are drawn through the hollow drill steel and chuck housing into the LX-1 dust box which is emptied by remote control lever on the drill throttle valve.

Steels never stick when they're on the business end of the *new* Le Roi LLV Dust-Collecting Air Leg Drill. The dustless drill melts its way through the hardest rock — piles up more drilling footage with a lower dust count than was ever possible with wet drilling.

Dry, dustless drilling permits continuous ore sampling — saves every speck of precious ore. It eliminates the need and expense of water — does away with wet, dangerous conditions; sinking pillars; lost holes; water and muck haulage.

The LLV collects dust through the drill steel and exhausts it through the chuck housing — *not the machine!* It's ideal for mining or tunneling in hard rock — saves tools and operators.

Ask your Le Roi distributor for a demonstration. Or for more information, write to the Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wis.

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PORTABLE AND TRACTAIR® AIR COMPRESSORS • STATIONARY AIR COMPRESSORS • AIR TOOLS

AT-907

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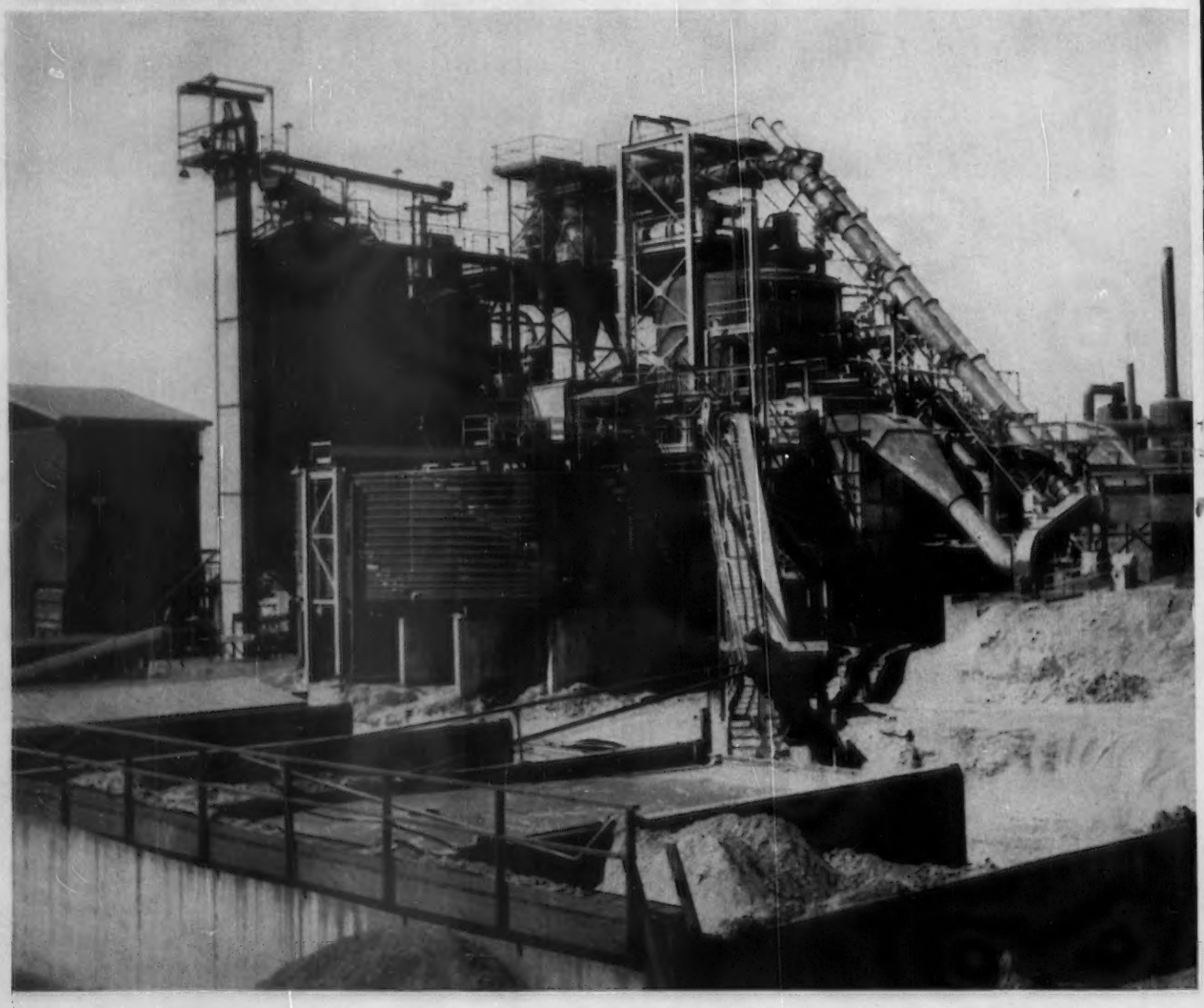
LPF PROCESS INCREASES FOR KENNECOTT

Dorrco FluoSolids System with Reactor, 22 feet in diameter, produces SO_2 for contact acid plant and hematite calcine for sponge acid plant from pyrite feed. Both materials are essential to LPF process.



This 80-foot Dorr Thickener, in foreground of filter plant at site of Hayden smelter, thickens overflow from cyclones used to dewater concentrates prior to filtration.

RECOVERY EFFICIENCY AT HAYDEN, ARIZONA

Dorrco FluoSolids System Provides SO_2 for Acid, Calcine for Sponge Iron

As part of a $40 million modernization program, Ray Mines Division of Kennecott Copper has installed leach-precipitation-flotation facilities at Hayden, Arizona. With this unique plant, Kennecott can treat lower grade ores, and expects to recover from each ton of ore more copper than can be extracted by flotation alone.

Pyrite recovered from tailings of the sulfide section of the Hayden concentrator is extracted by flotation and then roasted in a Dorrco FluoSolids system to produce SO_2 gas and an iron oxide calcine. The gas feeds a 100-ton-a-day sulfuric acid plant. Sixty tons a day of sponge iron are produced from the calcine by reduction with coal in gas-fired furnaces. Both acid and sponge iron are required in the LPF circuit.

At Hayden, the crude ore is separated into sands and slimes by Dorr Acid Proof Rake Classifiers for processing in sulfide and LPF circuits respectively. In the LPF circuit, acid is added as make-up to the tanks where the slimes are leached with acidic, copper-bearing pulp from the sand leaching circuit. This leached slime pulp, containing copper in solution and copper sulfide slimes, goes to precipitators. There an excess of sponge iron is added to drop the copper from solution. The finely divided cement copper and the copper sulfide slimes are then floated in an acidic circuit.

The resultant LPF concentrate and the concentrate from the sands treated by conventional flotation are joined for pumping to the filter plant at the smelter. Prior to filtration, the concentrates are dewatered by cyclones and the cyclone overflow is thickened in an 80-foot diameter Dorr thickener.

Whether your particular operation involves a new process like Kennecott's LPF plant, or a more conventional flow sheet, our many years of experience and our diversified equipment can help you solve your problems. Write to Dorr-Oliver Incorporated, Stamford, Connecticut.

Dorrco and FluoSolids—T.M. Reg. U.S. Pat. Off.

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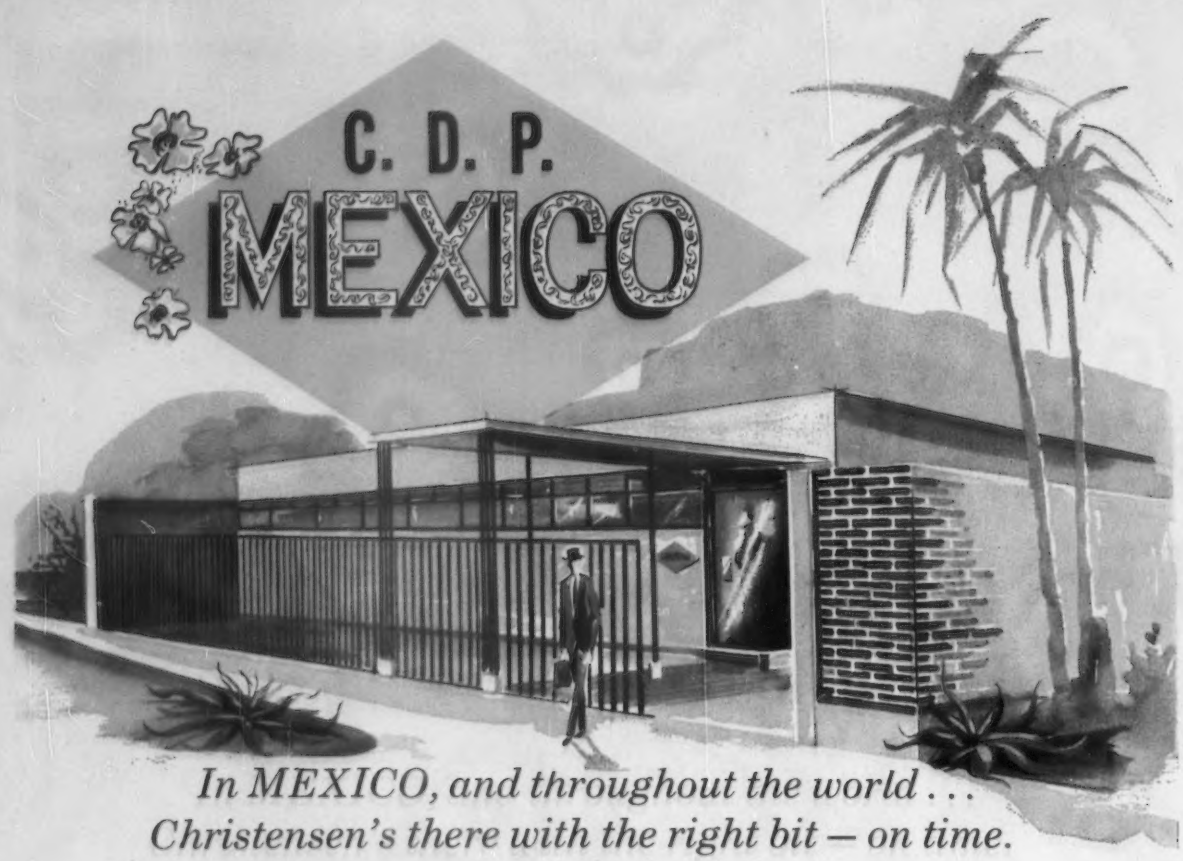

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Best Protection against Rust and Corrosion

Goodyear Rims with exclusive Bond-a-Coat finish

Note condition of rims after standard 48 hour ASTM salt-spray test. Exclusive Goodyear process thoroughly prepares the raw metal surface.

The above pictures clearly show the protective effect of Goodyear's exclusive process—Bond-a-Coat.

This unique finish—originally proved on Goodyear Agricultural Rims—keeps rims from rusting. More than that, it protects tires, too—helps you get maximum mileage out of every tire you buy.

Bond-a-Coat is just one of the reasons why you'll find it pays to specify Goodyear Rims, both for replacement and on new equipment. Some of the others:

Unusual strength: Thanks to special designs and closer tolerances, balance and alignment are greatly improved. As a result Goodyear's present-day rims are suited for today's needs.

Job-Fitted: Goodyear Rims are job-fitted. Result: less tread cracking, tread wear, reduced sidewall and bead failure.

Special tools: Goodyear provides both hydraulic and hand tools especially made for modern equipment.

Talk it over with your local Goodyear Rim Distributor. He'll help you pick out the type and size of rim best suited to your needs. Or write: Goodyear, Metal Products Division, Akron 16, Ohio.

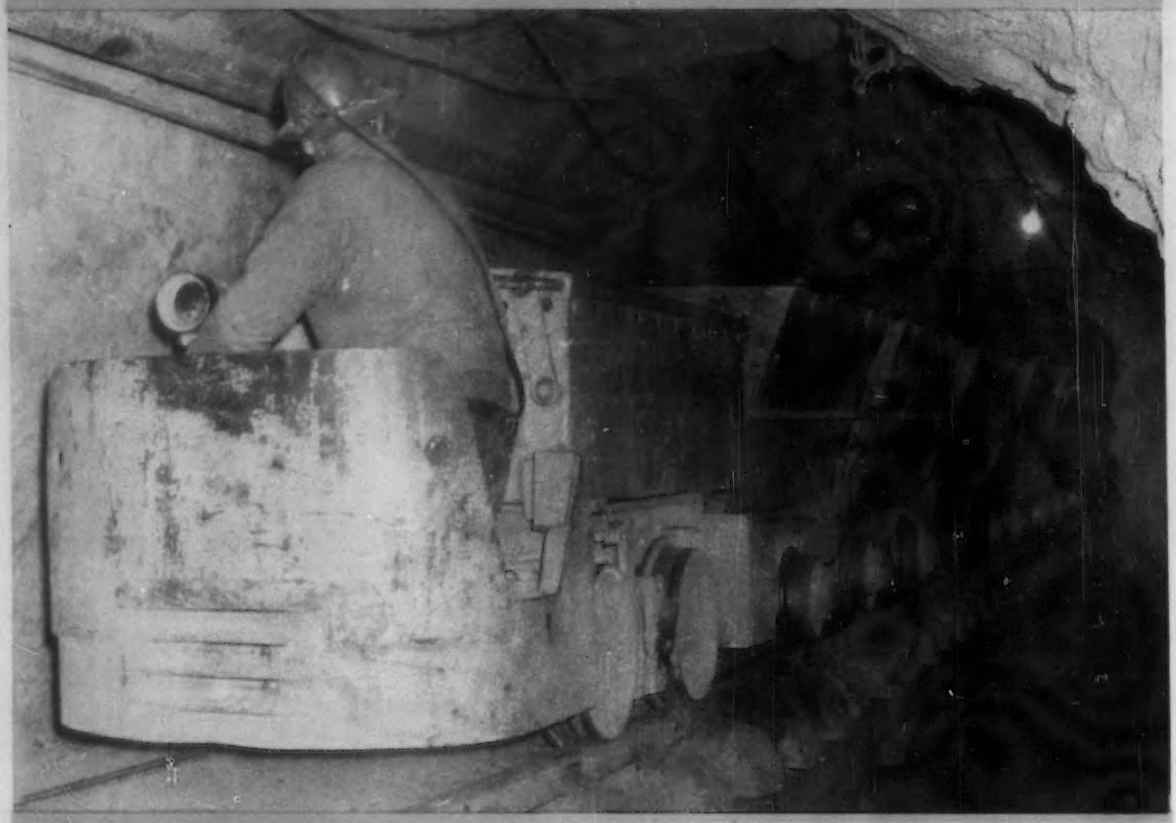
This is how Goodyear stores its rims—outdoors—thanks to Bond-a-Coat.

Your tires go farther on RIMS by

GOODYEAR

MORE TONS ARE CARRIED ON GOODYEAR RIMS THAN ON ANY OTHER KIND

MANCHA STORAGE BATTERY LOCOMOTIVE



Expediting Track Haulage of Uranium Ore

In the uranium rich areas of the Colorado Plateau and Canada's Blind River District 25 recently delivered Mancha 3-ton storage battery locomotives are providing low cost underground haulage.

Practical anywhere underground, these locomotives are maneuverable enough to service loaders in development headings . . . powerful enough to handle small mine production tonnage. Six to ten rocker dump cars, each carrying 1½ to 2 tons of ore is not an unusual load, and 150 tons per shift over a distance of 1,000 feet is just another job to them.

Mancha's patented Trackmaster design smooths out uneven track . . . cushions the battery as well as the motorman from a rough ride. More so, it improves overall performance by providing even drawbar pull to all four wheels through longitudinal equalizers and self-aligning journal bearings. The motor in the front end cast steel cab, is hooded to shed water and muck. A similar hood protects the controller.

In all respects, the Titan BN (3-ton operating weight) is a powerful—safe locomotive. What it provides in haulage economy for others, it can provide for you. Your inquiry is invited.

MANCHA STORAGE BATTERY LOCOMOTIVE

DIVISION GOODMAN MANUFACTURING COMPANY

Halsted Street and 48th Place • Chicago 9, Illinois • Cable Address: Mancha, Chicago

Mancha representatives are located in principal mining areas throughout the world.

Geoprene® Y-ground Portable Mining Machine Cable.

Super Coronol® Geoprene Type SH-D Ground Check Cable.

Super Coronol Geoprene Minepower Ground Check Cable.

General Electric offers a complete line of dependable cables

FOR A-C UNDERGROUND MINING

Here are three a-c underground mining cables from the complete G-E line which illustrate the hard-wearing, long-lasting qualities of *all* G-E mining cable:

Geoprene Y-ground Portable Mining Machine Cable. This cable, specifically designed for use on a-c shuttle cars, loaders, cutting machines, and the like, offers the utmost in flexibility and long life. The Y-shaped ground conductor separates three insulated-phase conductors, reducing the possibility of phase-to-phase faults in the event of cable damage. The Y-ground also has sufficient conductivity to trip the machine breaker, and simplifies the job of splicing.

Super Coronol Geoprene Type SH-D Ground Check Cable. The flexibility and sturdiness of this cable permit moving the load center forward without disconnecting the high-voltage power feeder. This cable, similar to standard Type SH-D, is available with an insulated ground check conductor in voltages up to 15 kv.

Super Coronol Geoprene Minepower Ground Check Cable. The non-metallic construction of G-E minepower cable provides light weight and ease of installation. The Super Coronol insulation on this cable—as on G-E Type SH-D cable — resists ozone, moisture, heat, and aging. The lead-cured neoprene jackets on both cables resist flame, oil, acids, alkalis, and sunlight.

These special-purpose cables meet various installation and application requirements. BOREHOLE CABLE • AERIAL CABLE • FLAMENOL* MINE TELEPHONE CABLE • SHOT-FIRING CORD • CORDX* LEAD-CURED TYPE SO CORD.

For complete information on General Electric cables for the mining industry, just mail the coupon for new, up-to-date bulletin.

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All General Electric mine cables bear the symbol P-108 of the Pennsylvania Department of Mines, and where required also carry the BM marking indicating listing by the United States Bureau of Mines.

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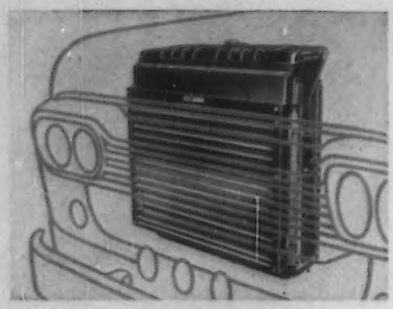
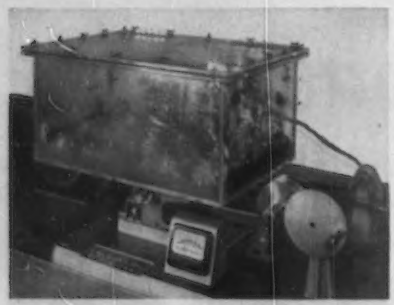
NOW! Certified Durability



CLOSER TEMPERATURE CONTROL obtained with automatic radiator shutters means longer engine life, more efficient operation. Temperature variation between 167° and 187° with shutters as compared to 102° to 181° without shutters was reported and certified in loaded vehicle road tests.



LONGER WIRING HARNESS LIFE is the direct result of Ford's greatly improved electrical wiring system for 1960. Ford's '60 wiring harness and the 1959 wiring harness were subjected to shaker table tests plus constant exposure to oil and water vapors, and temperatures of 200°. Certified test results show a threefold increase in 1960 wiring harness life.

INCREASED FUEL PUMP RELIABILITY is an added benefit from Ford's submerged-type electric fuel pump. Certified results of dynamometer tests showed no vapor lock with Ford's electric pumps at temperatures up to 200°, whereas incipient vapor lock with mechanical fuel pump resulted in a power loss of 9% under same conditions.

It's a fact! Numerous reports from high-mileage operators of Super Duty Trucks attest to Ford's outstanding durability. Studies by an independent research firm provide certified proof that these models are even more durable for 1960.

Ford Super Duty Trucks have earned a reputation for exceptional performance and durability since their introduction two years ago. Shop service records of many leading fleets show Super Duty tractors with mileage readings between 150,000 and 250,000 and no repairs other than normal maintenance. Similar testimony to the dependability of these Big V's by other satisfied users is being added each month. Is it any wonder that '59 sales of these units were more than double those of 1958?

And for 1960, the Ford Super Duties offer additional refinements. Bigger optional axles and increased GVW's to permit greater payloads and more profitable operation. Automatic radiator shutters to keep the engine temperatures within the most efficient operating range, improved submerged-type electric fuel pumps to prevent vapor lock, and redesigned wiring for more reliable operation are typical of the improvements to be found in these units.

The changes offered for 1960 were tested and evaluated by a leading research organization. Certified results of the studies by this impartial firm (name available on request) provide proof that Ford's Super Duty Trucks are even more dependable.

- **Certified Durability through closer temperature control!** Independent research engineers certify that Ford's thermostatically controlled radiator shutters kept water temperature between 167° and 187° in severe mountain grade operation. The test truck with shutters blocked open under same operating conditions had a temperature range from 102° to 181°. The temperature variation of only 20° with shutters means less expansion and contraction in block and heads. Higher, more constant temperatures permit oil to circulate more freely, reducing internal friction. All these factors contribute to longer engine life.

- **Certified Reliability with longer-lived electrical system!** Thicker insulation on wires resists deterioration by heat, oil and gasoline. Asphalt-impregnated loom and plastic-coated mounting clips protect against abrasion. Certified results prove that the 1960 wiring harness has three times longer life.

- **Certified Reliability with Ford's submerged-type electric fuel pump!** Dynamometer tests of engines with submerged-type electric fuel pump and conventional mechanical type showed that vapor lock was non-existent with Ford's electric pumps at temperatures up to 200°, whereas incipient vapor lock with mechanical pump resulted in a power loss of 9% at an underhood temperature of 200°.

Endurance tests were run on alternators, two-speed axle speedometer adapters and other related components with similar results. Get all the facts at your Ford Dealer's now!

in Ford Super Duties!

"Our first Ford C-1000 tractor has logged 190,000 trouble-free miles since March of '58,"

says Robey W. Estes, Vice President and General Manager of Estes Express Lines, Richmond, Va. "We haven't had a single road failure and we only bring it into the shop for regular preventive maintenance work once a month.

"We use the 477 engine and find oil consumption is exceedingly low . . . only one or two quarts added between 3000-mile oil changes. Engine compression at 190,000 miles is still high and fairly equal and our drivers say that power and pep are at about the same level as when the truck had been run only 60,000 miles.

"We are grossing between 52 and 56,800 pounds with our Ford Tilts. They are giving about the same gas economy and better oil mileage than other makes in our fleet. We bought our fourth Ford C-1000 tractor last month and hope to add more soon."

FORD TRUCKS COST LESS

LESS TO OWN . . . LESS TO RUN . . . BUILT TO LAST LONGER, TOO!

25-ton payloads . . . yet off-highway trucks average 4 to 6,000 hours before overhaul

For the past four years, six Euclid 36 TD dump trucks have played a key part in Mountain Copper Co. of California's open-pit mining operations near Redding. Using RPM DELO Supercharged #3 Oil, this fleet has already worked more than 40,000 hours without a lubricant failure.

Operating conditions are tough for the "Eucs"; put a real strain on their engines. Hauling iron pyrite ore to the crusher plant and removing waste (above), they must travel loaded down 7% grades. Payloads range up to 25 tons . . . dust is thick . . . and temperatures reach 105° for six months of the year. Despite all this, the trucks work from 4,000 to 6,000 hours before engine overhaul.

"We have no wear problems at all using RPM DELO Supercharged #3," says Master Mechanic Ben Jacklin. "Never had any lubrication trouble in any engine using it. The oil's done an outstanding job in our equipment."

RPM DELO Oils reduce wear and prolong engine life because they cling to parts whether the engine is running or idle. Anti-oxidant fights gum and lacquer formation, special detergent keeps parts clean. Other additives prevent corrosion, crankcase foaming.

Why not try RPM DELO Oils? Let them cut your costs, lengthen equipment life. Just call your local representative, or write any company listed below:

RPM DELO

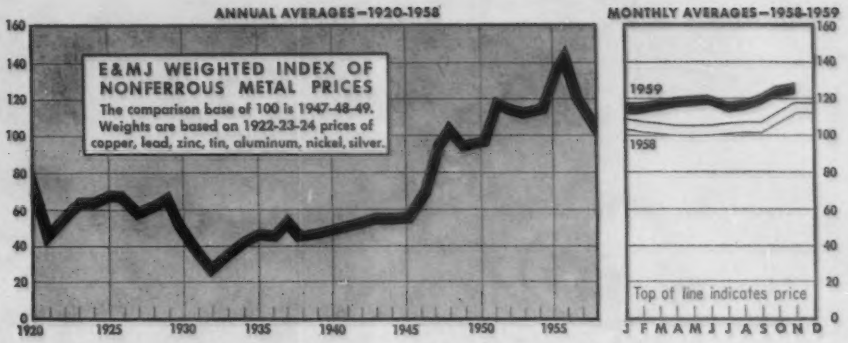
STANDARD OIL COMPANY OF CALIFORNIA, San Francisco 20 **STANDARD OIL COMPANY OF TEXAS,** El Paso

THE CALIFORNIA COMPANY, Denver, Colorado

TRADEMARKS "RPM DELO" AND CHEVRON DESIGN REG. U.S. PAT. OFF.

E&MJ OUTLOOK

PRICES



MARKETS

E&MJ's metal price index moved up sharply from 126.1 for October to 129.5 in November. Once again, copper scarcity due to the strike and improved zinc prices were the raising forces.

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AT HOME

The U.S. continues to lead the world in mineral production, according to USBM, but was displaced by the USSR in coal and iron ore last year. In a survey of 110 countries, U.S. ranked first in 29 of the 63 minerals covered, Russia in eight and Canada in three. The U.S. drop in iron ore was attributed to the recession.

Exploration in Wisconsin by Cerro de Pasco Mining Co. and Bear Creek Mining has been carried on during the past few months. Cerro has leased lands near old copper workings and Bear Creek is reported to be negotiating for leases in the northwestern corner of the state.

Electric power from hot gases is possible with the magnetohydrodynamic generator, unveiled by GE. Hot gas, speeding between powerful magnetic poles, has its free electrons diverted into an external load circuit by the bending forces of the field. General use, says the company, "is two decades away."

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LABOR

The strike settlement pattern has probably been set with the Kennecott-United Steelworkers agreement (see p 22). Asarco and Kennecott were making comparable offers to MMSW as we went to press.

Talks are continuing in the Copperbelt on improving the technical and financial advancement of negro labor.

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ABROAD

The Castro government of Cuba and Moa Bay Mining Co. (Freeport Nickel) were holding discussions at presstime on the new mine-tax law levied on concentrate exports. A company announcement noted that the talks were "an effort to achieve a workable basis on which the operation (Mobaco's $75-million mine and plant in Oriente Province) can go forward successfully under the legislation." The $119-million complex is ready to go into production (see pp 84-95). Earlier discussions between U. S. Ambassador Philip Bonsal and the Castro government broke upon Cuban reaction to anti-Castro moves by Cuban exiles now in the U.S. (See Washington Impact, p 20.)

Formal dedication of El Salvador mine in Chile was attended by government officials and Anaconda officials. The 100,000 tpy copper mine represents three times the metal output of Potrerillos, which it succeeds. (E&MJ, May p 118.)

THIS MONTH IN MINING

LINED UP in front of the new Wyoming producer are Cotter Ferguson, president of Gas Hills Uranium Co.; Nels W. Stalheim, president of Radorock and chairman of Federal; R. W. Neyman, president and general manager of Federal, and Raymond G. Lindlof, project manager at the site.

ONE OF THE TWO pits opened by the partnership to feed the new mill is observed by R. W. Neyman. Total cost of preparing the orebodies and constructing the new mill was put at $6-million. Construction took six months, represents the 24th U.S. mill built since the AEC program began

Federal-Radorock-Gas Hills Opens 522-tpd Mill

THE FEDERAL-RADOROCK-GAS HILLS Partners uranium mill in the Gas Hills of Wyoming began operating in late October, just six months after start of construction.

The start of operations marked the shortest time in which a major new uranium mill has been completed in the U.S., according to the AEC. Most mills, in the past, have taken a year or longer to construct.

The mill is owned by Federal Uranium Corp. and Radorock Resources, Inc., both of Salt Lake City, and the Gas Hills Uranium Co. with headquarters in Laramie. The partnership, which is managed by Federal, also controls extensive uranium ore deposits near the mill. Total cost of both mining and milling operations was put in excess of $6-million.

The mill, which incorporates the latest equipment and a continuous RIP Inflico system similar to that employed by the Maybell, Colo. operation of Trace Elements, was designed and built by Western-Knapp Engineering Co. of San Francisco. The mill is the 24th to be built in the U. S., and 10 of them have been built by Western-Knapp.

Mining operations are underway at two major orebodies near the mill, according to R. W. Neyman, president and general manager of Federal. Other orebodies which have been outlined by drilling, will be opened later to keep a steady flow of ore available to the mill.

The mill has a minimum rated capacity of 522 tpd permitted under the AEC contract. Of that amount, 389 tpd will be mined by the partners, and the rest is allocated to independent producers.

Contract with the AEC provides for a guaranteed market for an annual average of 779,000 lb of concentrates through Dec. 31, 1966. The partners claim they have ore to operate for several years beyond that date. Reserves are estimated at 1.5-million tons of 0.26% U_3O_8.

The contract for purchase with the AEC was signed April 10, 1959. Western-Knapp broke ground on April 14 and the first ore was received at the mill six months later, Oct. 14.

Cotter Ferguson, president of the Gas Hills Uranium Co. who lives in Laramie, was one of the pioneer prospectors of the Gas Hills area. He staked numerous claims, and in 1957 turned to Federal and Radorock to provide know-how and capital in developing the properties. Sufficient ore was developed by November 1957 to justify application to the AEC for the mill.

The mining areas—the Sagebrush "D" pit; Brush pit and Clyde pit—will be developed with an average 10-to-1 stripping ratio. Mining is now being carried out from the Sagebrush "D". The Brush pit is being developed. The pits are within 1.5 to 10 miles of the mill.

The Partners carry on their own mining and contract out stripping of overburden. Pit development is carried on by carry-alls.

The ore is so consolidated as to require little blasting. It is broken up by rippers, then placed on trucks by loaders.

Operations are expected to continue through most winter periods in the area. There is no known water problem—at least discernable by ore reserve coring. As mining progresses, it may be that certain narrow, high grade areas, will be mined out by underground methods with an addit going in from the pits. It is expected that average depth of the pits will be about 220 ft.

The ore is moved to conventional concrete pad, placed in selected grade areas for preparation of an average .24% U_3O_8 feed to mill.

Engineers have in mind certain cost-saving innovations but no changes will be made until after a substantial shake-down period in the existing, designed process.

Under terms of the partnership, Federal and Radorock will first recover their expenditures in developing the properties and then will share profits on a basis of 30% each for Federal and Radorock and 40% for the Gas Hills Uranium Co.

Mill employes will live at a camp constructed nearby the the partners. Approximately 100 workers will be employed in mining and milling. Raymond G. Lindoff is project manager for the Federal Partners, and Arthur W. Griffith is general milling superintendent of Federal.

Wabush Iron's Railroad Aims for 1960 Completion

INLAND STEEL CO. and Pickands Mather & Co. have joined a group of U.S. and Canadian iron ore and steel companies which have organized the Wabush Iron Co., Ltd. for the development of an extensive body of iron ore in the Wabush Lake area of Labrador (E&MJ, March, p 18). Their long term lease covers an area of five square miles and government estimates place the potential tonnage at one-billion tons of low grade ore. The property is near Labrador's western border, 200 miles north of Seven Islands and 37 miles from the Quebec, North Shore & Labrador Ry. The 37-mile connecting road will be completed in 1960. A pilot plant is under construction and will be-

gin shipments in 1960 (E&MJ, August, p 82) of enough concentrated ore to permit large-scale tests in steel plants. Construction of a permanent plant is planned to begin in 1961 with an initial capacity of 4- to 5-million tpy, starting in 1965; and an ultimate production of 10-million tpy at a total cost of $200-million or more. That would include plant, townsite, railroad connection and shipping facilities at Seven Islands. Wabush Iron Co., Ltd., is owned by Youngstown Sheet & Tube Co., Steel Company of Canada, Ltd., Interlake Steel Corp., Pickands Mather & Co. and Inland Steel Co. Pickands Mather & Co. will be the operating organization.

Philip D. Block, vice-chairman of Inland Steel Co., said that the low grade Wabush ore concentrates and the product will be a highly desirable ore for his company's blast furnaces. Mr. Block also said that Inland would continue to receive the greater part of its ore requirements from the Lake Superior area. The company has the Bristol and Sherwood mines on the Menominee range of Michigan and the Armour mine on Minnesota's Cuyuna range.

Caland Ore Co., Ltd., Inland subsidiary, is also developing a property at Steep Rock in western Ontario, under lease from Steep Rock Iron Mines, Ltd. from which it is expected to make its first shipments in 1960.

Mining Calendar

Northwest Mining Association, Spokane, Wash. Dec. 4-5

Annual meeting, AIME, New York, Feb. 14-18, 1960

Australasian Institute of Mining & Metallurgy, Adelaide Branch Symposium on Hydrometallurgy, "Wet Processing of Minerals and Industrial Products," Feb. 16-19

Governor's Industrial Safety Conference, statewide meeting, San Francisco, Calif. Feb. 16-17

Symposium on Pilot Plants in Metallurgical Research and Development, Jamshedpur, India, February

National Western Mining Conference and Exhibition. Denver Hilton, March 17-19

Fifth International Mineral Processing Congress, Westminster, London. The Secretary, Institution of Mining & Metallurgy, 44 Portland Place, London, W.1, England. April 6-9

Southwest Metals & Minerals Conference, AIME, Los Angeles, Calif. April 21-23

International Congress on Research into Ground Control and Rock Mechanics, Paris, France. May 16-20

Wyoming Mining Association, Jackson Lake Lodge, Wyo. June 10-11

XXI International Geological Congress, University of Copenhagen, Denmark. American Geological Institute, 2101 Constitution Avenue, N.W., Washington 25, D.C. Aug. 15-25

(*This Month continues p 128*)

As We Went to Press . . .

Elimination of a long standing block to the expansion of Mt. Isa mines, in Queensland, Australia is finally being effected. F. Frank R. Nicklin, premier of Queensland, has signed an agreement with Ford, Bacon & Davis for the engineering, design, and construction management work for a $67-million program to expand the railway system, with work to begin in early 1960.

Mt. Isa is in the midst of an expansion which will triple its ore output by 1965, a project which had been delayed for many years because of the lack of transportation to the coast.

The new agreement provides for 750 miles from Townsville to be rehabilitated, with new trackage where necessary, replacement of timber trestle bridges, provision of motive power and rolling stock, yards, terminals and office buildings.

Three new miners' organizations have been formed to oppose some restrictive government regulation and to improve the condition of the industry in the U.S.

Prospectors and Miner, Inc., of Grangeville, Idaho, is composed of industry members from north central Idaho, dedicated to improving the outlook and productivity of the industry. Their first target is the Federal withdrawal of 260 acres of land along Clearwater River, in Idaho County. (E&MJ, November, p 158.)

The second organization, formed to "augment or support the activities of other mining groups," is the American Metal Mine Owners, headed by Joseph E. Little, an attorney of Denver, with former Governor of Colorado Dan Thornton as vice chairman and George White, of Denver, as field representative. Restoration of gold and silver in the West is this group's first objective.

The American Mineral Resources Association was organized in Salt Lake on Nov. 7 "to promote the welfare of all industries involved in mining, oil and gas, water conservation and public lands." Legislative action is the primary aim of the third group, headed by Duane C. Randall, of Moab.

An extended uranium contract to June 30, 1965 for delivery of yellow cake to AEC was signed by Kerr-McGee Oil Industries Nov. 23, which will mean continued production from the 300-tpd Shiprock mill. The plant is shut down at present for construction of a solvent extraction circuit to recover high purity vanadium concentrate. Production will continue at 300 tpd.

The industry was shocked to learn of the sudden death of John D. Bradley and his wife in a head-on collision in San Francisco, Nov. 26. The Bunker-Hill president was driving in the outside lane of a freeway when an oncoming car leapt the divider and flipped into the path of his vehicle. The Bradley's son, John A., also a passenger, was seriously injured.

A group of Idahoans who are suing the U.S. Government for damages on the ground that the AEC allegedly failed to abide by agreements to buy uranium ore has been ordered to give details to support their claim by the Court of Claims. (E&MJ, November, p 134.)

WASHINGTON IMPACT

Highlights

COPPER DISPOSAL FIGHT BREWS—U.S. Government disposal of surplus copper from its overloaded inventories is again a hot issue in Washington. Now the question is not so much one of whether or not some copper will be released, but how.

The controversy goes back to last spring, when Office of Civil and Defense Mobilization was considering selling off up to 136,000 tons of copper from its Defense Production Act inventory, disposal of which is not subject to specific Congressional authorization.

After brief rumors—firmly denied—that major copper producers would not oppose such a move because of impending labor strike troubles, Congressional reaction solidified in violent opposition to any such move at that time. Led by the so-called Mining Bloc of 16 western Senators, Congress let OCDM know unofficially it would fight any release of copper. On top of this reaction, the London Metal Exchange fluctuated erratically to the rumors, and the plan was shelved.

As the copper labor strike came and lasted, however, pressure increased from domestic smelters and fabricators—particularly on the Commerce Department's Business and Defense Services Administration, which handles defense allocations and priorities—to ease mounting shortages.

A few months ago, Congressional staffers, in almost daily contact with OCDM, informally advised the agency that the Mining Bloc would not object to the sale at prevailing market prices of up to 100,000 tons of copper from the DPA inventory. But the Congressional spokesmen placed two qualifications on their acquiescence: first that no release be made until after the strike was settled, and second, that only in case of a truly international emergency should any copper be sold.

Subsequently, the Congressional Mining Bloc upped its figure to 125,000 tons, but insisted on its qualifications. OCDM, according to Capitol Hill observers, agreed in principle.

Now, however, the fight is broken open anew. Point of argument this time is whether any Government copper to be sold should be released through BDSA, or channeled through the major industry producers.

The smelters and fabricators want BDSA to handle allocation of the released stocks. The Mining Bloc is insisting that an agreement be worked out through the major producers and OCDM, calling on the industry leaders to buy and sell the stockpiled copper at no profit as an orderly dispersal of needed supplies.

The obvious angle is one involving a question of anti-trust, should private industry producers be permitted to handle the disposal. Furthermore, the Administration is free to dispose of DPA inventory materials without specific Congressional okay. But OCDM has another point to consider, too. That is the Capitol Hill acceptance of its proposed new legislation to authorize freer disposal rights for all stockpiled materials. As of now the controversy is getting more and more bitter, and seems far from final settlement.

URANIUM POLICY DECISIONS—U.S. uranium miners got a scare and a boost from Washington last month. The boost was an Atomic Energy Commission decision that cut off all Government purchases of Canadian uranium concentrates at existing contract obligation levels.

This means that no Canadian uranium will be bought above and beyond what the AEC already has contracted for. However, to ease the impact on Canadian miners, AEC agreed to stretch out delivery dates beyond their present 1962-63 time schedules.

In effect, this merely wraps up what has been an established trend. Since the Government started buying uranium in 1943, over 15,000 tons has been U.S.-mined, more than 18,000 tons foreign produced. But two-thirds of the foreign sales came in the first six years of the program. Since 1949, domestic suppliers accounted for 90% of the total amounts bought.

The scare thrown into domestic producers came from Treasury Department. Internal Revenue Service reportedly was considering re-jiggering the 23% depletion allowance to exclude the so-called "yellow cake" processing procedures from this tax deduction. The Senate Mining Bloc protested, and Capitol Hill sources say they have been assured IRS will not change the existing formula.

Washington Seeks Easing Of U.S.-Cuban Tensions

CUBA'S NEW MINE TAXES (see Freeport story, page 84) are only a part of a pattern of fast-deteriorating relations between prime minister Fidel Castro's one-man government and Washington. The situation is such to frustrate and seriously concern U.S. officials. An eventual accommodation is important to U.S. investors who have—or had—close to a $1-billion stake in the Caribbean island, including the Government's $75-million nickel plant at Nicaro, Freeport Sulphur Co.'s $75-million nickel and cobalt processing facility at Moa Bay, National Lead Co.'s holdings of ore deposits and reserves, as well as larger investments in sugar, oil, electric power and other Cuban operations.

A solution is being almost desperately sought, too, for political reasons. And it is in the political arena, as well as on the economic front, that hopes of U.S. businesses in Cuba—present and future—rest. For that reason, domestic mining industries will be closely watching developments over the next few months. Up to now, the picture has been grim.

Analysts of Castro's revolution were bullish back on Jan. 1, when the barbudo leader routed former dictator Batista. Conceding that his volatile personality posed something of an enigma, area experts nevertheless attributed Castro with a keen sense of economic realism and a sincere desire to lift Cuba out of the condition inherited from Batista. On the surface, the Cuban economy was expanding. But its main support came from tourism and gambling, and corruption stifled hopes for much more solid industrial development.

Despite Castro's war crimes trials and neutralist leaning toward the Cold War, U.S. officials felt he had a broad base of Cuban popular support, including cool business and financial experts as well as the peasants and a general public fed up with Batista.

Washington, therefore, has been inclined to look tolerantly on even Castro's agrarian reform program, in the hope that advice from aides more moderate and practical than Castro himself would keep his economic programs on a fairly even keel.

As the first year of Castro's administration draws to an end, however, these official hopes have not panned out. In addition to Castro's mine taxes, he has slapped on heavy import restrictions, seized company files, and—worst of all from Washington's viewpoint—stopped informal talks aimed at "negotiating" settlements with dispossessed or threatened U.S. investors.

Here, of course, is where the political angle comes in. Castro's harassment of U.S. business interests in Cuba has been mild compared to his new anti-Yanqui campaign and reckless charges of U.S. complicity in his political foes' equally

irresponsible propaganda activities.

Washington's role in U.S.-Cuban relations has a near-tragic air. In the first place, poor official intelligence reports on the island misled the U.S. government into believing Castro had virtually no chance of pulling off his coup d'etat. Worse, U.S. ambassador Earle T. Smith was generally accused of favoring Batista.

Bad luck in political relations has continued to plague the State Department. Even after Smith's recall and the appointment of Philip Bonsal—a man widely admired and respected in Cuba—the Senate Internal Security Subcommittee's airing of ex-Castro aide Diaz-Lanz's charges that Castro is a Communist gave seeming official sanction to that view.

This is a view that Cuban experts in the U.S. Government do not share. Nor did the U.S. Government sanction or even wink at the recent Diaz-Lanz "leaflet raid" on Havana which kicked off Castro's latest anti-American campaign. Major Diaz apparently took off from a Florida airport undetected.

Nevertheless, the two Diaz-Lanz episodes, coupled with other diplomatic "accidents" have broken off informal talks between Bonsal and Castro aides which Bonsal had just reported showed signs of progress. The talks were aimed at softening the effect of Castro's agrarian reform program and the new mining taxes on U.S. business interests.

There remains a possibility that the talks, plus direct negotiations between Castro officials and U.S. investors may get a fresh start. Despite the stringency of Cuba's new curbs on foreign investment and ownership, loopholes in their administration may be found.

For example, the 25% export tax on minerals shipped out of the country is based on assessed value. In Freeport's case, the nickel-cobalt ore exported is in concentrate, for processing at the company's Louisiana plant. The assessed value of this ore conceivably could be placed at a low enough rate so that even the stiff 25% export tax would not be totally uneconomic. GSA has as yet not been notified that the tax applies to Nicaro.

These hopes, slim as they are, are based on a belief in Washington that sooner or later Castro's advisers will convince him he needs U.S. investment if Cuba's economy is to be saved at all from the slump it is now heading into. Unofficially, Government officials also are counting on local business pressures inside Cuba to move in the same direction. Castro has alienated much of his initial business support on the island. Washington hopes that he will adopt a more moderate approach to U.S. investors to regain that support if for no other reason.

Whether he again swings back to taking the advice of the more thoughtful of the various Cuban business leaders may depend on his mercurial whims. But U.S. officials think that hope is worth playing. They say, too, that it may depend on the patience and diplomacy of Bonsal and U.S. interests, as well.

Labor This Month

IN THE STEEL STRIKE SHADOW—COPPER: The White House has given out an uninhibited definition of the dispute between the big copper companies and the Mine-Mill and Smelter Workers Union. It came from President Eisenhower's deputy assistant, Gerald D. Morgan, in a letter to Sen. Frank E. Moss (D. Utah). Moss had requested a Presidential fact-finding board to help settle the copper strike. Morgan rejected the idea because it "constitutes an unwarranted interference with the process of free collective bargaining."

But then the letter almost contradicts itself. Morgan adds: "apparently most of the parties in the nonferrous industry are awaiting some clarification of the steel dispute situation before engaging in definitive negotiations." The first copper settlement did, in fact, look like the Kaiser Steel settlement when Kennecott and the United Steel workers signed a 22¢ an hour two-year agreement.

UNIONS PROMOTE IMPORT CUSHION: The rising competition of imports in copper, steel and other industries is forcing a shift in labor's traditional support for free trade. In a new policy statement, the AFL-CIO spells out its ideas. The labor federation still favors a lowering of trade barriers through the Reciprocal Trade Agreements program. But, in those industries where foreign competition is beginning to hurt, the AFL-CIO wants trade adjustment established.

The program would provide assistance to workers, firms and communities hit heavily by imports—either by financial and technical assistance to make plants more efficient, and therefore more competitive—or by helping such plants shift into more lucrative lines of business.

AN ALL-UNION STRIKE FUND: Walter Reuther and other top labor officials are aiming for a multi-million dollar union treasury to support labor strikes. The strategy is evolving out of the AFL-CIO strike fund built up in support of the United Steelworkers. In a campaign to collect one hour's wages a month among the AFL-CIO's 12.5-million members, the Steelworkers strike fund has climbed well beyond the $5-million mark. A general fund is still in the talking stage but the rash of 1959 strikes places it high on the agenda of future labor goals.

Unions involved in the copper strike favor the idea. In fact, they appealed to AFL-CIO president George Meany for a share of the steel strike kitty to help finance their own walkout. If a central strike fund is established, it would add new impetus to Mine-Mill's drive to return to the big labor federation.

A LABOR-MANAGEMENT SUMMIT CONFERENCE: Not since 1946 has the nation been hit by a wave of critical strikes to match this year's record. It includes such bitter disputes as copper, steel, meatpacking, rubber and textiles. Union officials for some time have been promoting a Government-sponsored peace conference between top officials of industry and labor. President Eisenhower is now backing the plan. The aim is to end such industrial warfare through discussion, and emphasis on mutual interests and goals. Bargaining issues would not be part of the conference agenda, in hopes of avoiding a conference breakdown. Eisenhower defines the subject matter as "the common problems having to do with improving the health and efficiency of the industries and companies with which they are concerned."

THE TEAMSTERS' HOFFA—A SIX-MONTH TARGET: When the Supreme Court recently refused to curb the power of court-appointed monitors to clean up the Teamsters Union, it hit like a thunderbolt at the truck union's national headquarters. This was the first big dent in the armor of union president James R. Hoffa who, up to now, has survived a series of Government and union efforts to dethrone him. Now, the monitors have a final legal okay to pursue their campaign to oust alleged racketeers from Teamster leadership. Their number one target is Hoffa himself. The schedule of the monitors, headed by attorney Martin F. O'Donoghue, calls for quick charges against the Detroit labor leader—then await his legal challenges. They expect a definite result at the end of six months.

MARKETS

Copper, Lead Strikes Settled; Copper Prices Ease; Aluminum Output Cut

PRICES OF NON-FERROUS METALS in November rose to 129.5% of the 1947-'49 average according to the E&MJ index of non-ferrous metal prices. October was 126.1. The increase was mainly due to the rise in copper to 34.060c from 32.576c a lb in October. The rise in zinc to 12½c from 12.121c contributed to the increase in the index.

Kennecott announced that its price for electrolytic copper would be 33c a lb December 1, when it began shipping metal. All fabricators had gone to the 33c pricing basis for fabricated products, including Kennecott subsidiaries.

The Kennecott announcement followed settlement of its strikes with Mine-Mill and USW. But the copper to be priced will come from the company's new refinery in Maryland as well as its Garfield refinery. In November the Maryland refinery converted some cathodes into wire bars, probably for some independent buyer. Late in the month the plant was undergoing the normal de-bugging in connection with refining blister into anodes. The blister probably comes from Chile. Kennecott will be paying the 1.7c import duty on this copper.

Kennecott settled its strike by USW late in November. The agreement provided gains for the USW workers of 22.3c per hour. It includes 8.7c per hour immediately, another 8.7c August 1, 1960 and 4.9c in fringe benefits. The company is negotiating with Mine-Mill, certain craft unions and the railroad brotherhoods. Mine-Mill, which has more workers than the others, will probably settle for about the same as USW.

The Kennecott agreement with USW appears to have set the pattern for the non-ferrous industries. Asarco made an offer to Mine-Mill not much different from the Kennecott—USW arrangement.

Phelps Dodge is not as far along in its negotiations with striking unions as Asarco but chances are good it will settle with Mine-Mill and USW at close to the Kennecott level. Anaconda and Mine-Mill broke off negotiations about the last of November. The company has confirmed the view that it has high costs in the Butte area and that it can hardly afford to pay the amount the unions want.

It is uncertain what the higher wage and related payments will cost the companies. Many factors suggest it will be about ¾c a lb. It raises the break even point for all companies. Since copper production costs vary widely it is not possible to attribute, yet, any permanent cessation of production to this wage increase, but it could make the difference for some smaller mines and possibly to Anaconda. It is not certain that prices in the long run will average higher than in the past by the amount of the increased cost since copper is imported from other areas in which costs may be rising by less. Also, new properties (which could be paying high wages) might be low cost because of physical reasons.

Some copper prices moved down as settlement of strikes appeared certain. The London Metal Exchange dropped from £259 prompt bid November 12 to £237 November 27; December 1 it was £239½. On November 30 U.S. merchants were offering prompt wire bars for nearby delivery for about 36½c to 37c, down about 3½c from the high. Prices charged in the U.S. by agents of foreign producers had dropped 2 or 3c from the high point. Katanga and other sellers outside the U.S. had dropped.

The only U.S. producers who had been selling copper remained with the 33c delivered price.

Brass mills, most of which get half or more of their copper from scrap, have operated at a good level. Wire mills were shorter on copper. Copper data show that at the end of October fabricators had in the U.S. 431,612 short tons of copper; most of this was in products and in process—not much was in raw copper.

It will be several weeks before copper is flowing freely, but it appears there will be no real shortage. Buying to maintain end of year stocks at the same level as last year (for income tax purposes) may keep markets firm in the U.S. But early in 1960 there could be some easing. If 1960 is a boom year for the economy most copper companies will have a financially good year.

Lead sales in November were exceptionally low and not much different from September and October (September was about 12,400 tons and October about 14,400 tons). Shipments were much higher reflecting the heavy sales made in August (about 51,000 tons by U.S. smelters) and in April and May (over 50,000).

With the imminent settlement of strikes against lead plants some factors are repeating the notion heard early in the fall—lead prices will drop. This view is based on the fact that lead from outside the U.S. is available at about 12c, 1c under the U.S. New York price. Smelters do not like to accumulate ores, or metal from ores, bought at a price higher than the price at which they feel they will be able to sell. Stocks are now 115,418 tons according to the American Bureau of Metal Statistics. Though this is down from earlier in the year it is still high. The lead strikes cut back on refining, not much on mining; there has been an accumulation of ores awaiting refining.

Six major U.S. smelters of lead and zinc petitioned the U.S. Tariff Commission to drop import quotas and replace them with higher tariffs. They are the same six that suggested such action to the Commerce Dept. in August (E&MJ, Sept. 1959, p 22)—Asarco, American Zinc, Athletic Mining & Smelting, American Metal's Blackwell Zinc Co., Mathiessen & Hegeler and International Mineral & Metal's National Zinc Co. The six smelt 57% of the lead smelted here and mine 4.4% of U.S. mine output; they smelt 44% of U.S. zinc and mine 13.5%.

The Tariff Commission had already arranged hearings for Jan. 12 partly in connection with the sense of Senate Resolution 162.

Zinc sales in November were very low. This was expected because September and October sales were very high. Buyers had come into the market for large tonnages when the price was raised—most of the heavy sales were at the lower prices.

Zinc stocks in the U.S. remain high according to Zinc Institute data. Shipments in October of Special High were 37,002 tons; only in June were 1959 shipments higher. With steel again in production it is expected that Prime Western shipments will rise—if this occurs stocks of zinc should drop (unless output increases are large—there are reports some firms plan to increase production).

Aluminum prices are likely to rise. Aluminum unions, USW and others, have been working since July 31 with the agreement that wage increases will be retroactive to that date. Agreement has waited on the steel industry to set the pattern. It is almost certain aluminum workers will get a rise eventually and that it will most likely be close to what copper workers have gotten. Such a wage increase will likely mean from ½c to 1c a pound increase in cost. When the retroactivity cost is added a price increase seems necessary.

Kaiser announced it is cutting output further—it is dropping out another line at Mead, Washington. It will now be at about 76 or 77% of capacity. Kaiser will own 49% of a new aluminum fabricating firm in Argentina; Guillermo Decker, S.A., an Argentine copper fabricator will hold the rest. Alcoa will own 35% of a new Mexican primary producer that should be in production in two years. Alcoa made its first shipment of primary aluminum to Imperial Aluminum in the U.K. It owns 49% of the firm.

Aluminum Company of Canada indicated it is selling aluminum to Red China—it has probably sold about 5,000 tons in the past few months. It said it is making these sales because competing aluminum companies have sold there. A Toronto newspaper, in discussing this, also said: "Meanwhile, the company has also been competing with some of the North American producers in selling small quantities to communist nations in Eastern Europe."

Average Prices November (E&MJ Quotations)

Cents per lb unless otherwise indicated:

Copper:	
Electro, domestic refinery	34.060
Electrolytic, export refinery	30.481
Electrolytic, c.i.f. Cont'l ports	31.426
Lead:	
Common, New York	13.000
Common, St. Louis	12.800
Silver:	
Silver, New York, per oz	91.375
Silver, London, pence per oz	80.250
Zinc:	
Prime, Western, East St. Louis	12.500
Prime, Western, delivered (g)	13.000
Tin:	
New York Straits	101.042
Gold, per oz, U.S. price	$35.000
Sterling, Exchange	280.268
Quicksilver, per flask	$216.611
Antimony, (E&MJ) (d)	32.590
Antimony, bulk, Laredo	29.000
Antimony, in cases, Laredo	29.500
Antimony, for 99½%	24.500
Platinum, refined, per oz	$77.000
Cadmium (a)	130.000
Cadmium (b)	140.000
Al, 99½% dom., ingot	26.800
export, pig	22.500
Magnesium, ingot	35.250
Nickel (f)	74.000
Bismuth	$2.250
Cobalt	$1.750

Domestic quotations, unless otherwise stated are in cents per lb. Sterling exchange checks, in cents. Quicksilver per flask of 76 lb.
(a) Per lb delivered, ton lots.
(b) Per lb delivered, small lots.
(d) Domestic 5 tons or more but less than carload lots, packed in case f.o.b New York.
(f) Contract price, f.o.b. Port Colborne U.S. duty included.
(g) Delivered where freight exceeds 0.5c.

Custom Smelter Copper

Based on flat price and E&MJ average prices sales in U.S. for month of November reported by American Smelting & Refining Co.; electrolytic copper in standard shapes, adjusted to nearest ⅛c; ¼c deducted for selling common.

Delivered consumers' plant	no quote
F. o. b. refinery	no quote

Free Gold Market

International gold transactions rose 33⅓% during November on large central bank dealings. Coin prices gained between ½ to 1½%. London's volume of gold transactions, spurred by Soviet sales of 40 tons, rose to over $40-million. Paris averaged daily volumes of about 1.1-million with over half the dealings in coins. Indian bar and coin prices declined somewhat reaching a 4-year low. Gold futures were active in Switzerland where daily volumes were reported to be increasing especially for the accounts of American residents. PICK'S WORLD CURRENCY REPORT quotes on "free gold" per fine oz as follows:

	Coins		Bars (12.5 kg)	
	Oct. 30	Nov. 30	Oct. 30	Nov. 30
New York transit	.....	.....	$35.08⅛	$35.08⅛
Manila	$41.00	$40.50	35.85	35.80
Hong Kong	46.10	46.20	38.60	38.50
Bombay	57.50	52.00	55.75	51.75
Tangier	39.50	38.10	35.25	35.15
Beirut	40.50	40.50	35.18⅛	35.18⅛
Paris	40.00	40.25	35.70	35.70
Buenos Aires	38.75	38.75	35.80	35.90

Note: Prices are quoted at the free or black market value of the U. S. dollar in the local markets.

Major Metals

U.S. DAILY AND AVERAGE PRICES

Cents per lb unless otherwise indicated:

Nov. 1959	Electrolytic Copper (a) Domestic	(b) Export	Europe c.i.f. (c)	Lead New York	Lead St. Louis	Zinc (f) Delivered	Zinc East St. Louis	Aluminum Primary Pig 99% U. S. Dest.	Straits Tin New York
2	32.900	30.825	31.770	13.000	12.800	13.000	12.500	24.700	101.500
3	Holiday	30.675	31.620	Holiday					
4	32.725	30.875	31.820	13.000	12.800	13.000	12.500	24.700	101.375
5	33.550	30.725	31.670	13.000	12.800	13.000	12.500	24.700	101.250
6	34.650	31.575	32.520	13.000	12.800	13.000	12.500	24.700	101.250
9	34.525	31.525	32.470	13.000	12.800	13.000	12.500	24.700	101.250
10	34.625	32.025	32.970	13.000	12.800	13.000	12.500	24.700	101.750
11	Holiday	32.575	33.520	Holiday					
12	35.175	31.250	32.195	13.000	12.800	13.000	12.500	24.700	101.500
13	34.675	31.575	32.520	13.000	12.800	13.000	12.500	24.700	101.375
16	34.800	31.300	32.245	13.000	12.800	13.000	12.500	24.700	101.250
17	34.750	30.425	31.370	13.000	12.800	13.000	12.500	24.700	101.000
18	34.725	30.300	31.245	13.000	12.800	13.000	12.500	24.700	101.125
19	34.150	29.950	30.895	13.000	12.800	13.000	12.500	24.700	101.000
20	33.850	29.925	30.870	13.000	12.800	13.000	12.500	24.700	100.875
23	33.675	28.850	29.795	13.000	12.800	13.000	12.500	24.700	100.625
24	34.025	29.100	30.045	13.000	12.800	13.000	12.500	24.700	100.250
25	33.825	29.500	30.445	13.000	12.800	13.000	12.500	24.700	100.500
26	Holiday	29.125	30.070	Holiday					
27	33.225	28.975	29.920	13.000	12.800	13.000	12.500	24.700	100.625
30	33.225	29.025	29.970	13.000	12.800	13.000	12.500	24.700	100.250
AVERAGES FOR MONTH									
Nov.	34.060	30.481	31.426	13.000	12.800	13.000	12.500	24.700	101.042
AVERAGES FOR WEEK									
Nov.									
4	32.875	31.095	32.040	13.000	12.800	13.000	12.500	24.700	101.531
11	34.338	31.685	32.630	13.000	12.800	13.000	12.500	24.700	101.375
18	34.825	30.970	31.915	13.000	12.800	13.000	12.500	24.700	101.250
25	33.905	29.465	30.410	13.000	12.800	13.000	12.500	24.700	100.650
CALENDAR WEEK AVERAGES									
Nov.									
6	33.456	30.935	31.880	13.000	12.800	13.000	12.500	24.700	101.344
13	34.750	31.790	32.735	13.000	12.800	13.000	12.500	24.700	101.469
20	34.455	30.380	31.325	13.000	12.800	13.000	12.500	24.700	101.050
27	33.688	29.110	30.055	13.000	12.800	13.000	12.500	24.700	100.500

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices, except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.400c per pound, the average differential for delivery charges.

(b) Export copper daily quotations are weighted averages based on sales outside the U.S. reported to E&MJ. Ocean freight and 0.125c lighterage and handling are deducted to arrive at the f.o.b. Atlantic seaboard refinery quotation. On f.a.s. U.S. sales lighterage of 0.125c is deducted.

(c) The c.i.f. Continental ports quotation is arrived at by adding to the f.o.b. export quotation lighterage, and the standard conference freight and insurance, Atlantic ports to main Continental ports. Currently this is 0.125c and 0.82c.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingots; cathodes are sold at a discount of 0.125c to 0.15c per pound. Quotations for zinc are based on Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East, Middle West, and West effective Sept. 2, 1959, commanded a premium of 1.25c per pound over the current market for Prime Western; Special High Grade 1.50c effective Sept. 2, 1959.

(f) Prime Western delivered where freight from E. St. Louis exceeds 0.500c.

Quotations for lead are based on domestic common lead. Corroding lead commands a premium of 10 points (almost all U. S. lead is corroding grade).

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

Nov. 1959	Silver (c) New York	Silver London	Sterling Exchange	Gold (d) London
2	91.375	80.250d.	280.4040	250s. 1½d.
3	Holiday	80.250d.	Holiday	250s. 2d.
4	91.375	80.250d.	280.2866	250s. 1½d.
5	91.375	80.250d.	280.2100	250s. 2¼d.
6	91.375	80.250d.	280.2440	250s. 2½d.
9	91.375	80.250d.	280.3020	250s. 2d.
10	91.375	80.250d.	280.4020	250s. 1d.
11	Holiday	80.250d.	Holiday	250s. 0d.
12	91.375	80.250d.	280.3600	250s. 1¼d.
13	91.375	80.250d.	280.3000	250s. 1¾d.
16	91.375	80.250d.	280.2640	250s. 2¾d.
17	91.375	80.250d.	280.1920	250s. 3d.
18	91.375	80.250d.	280.1620	250s. 3d.
19	91.375	80.250d.	280.3080	250s. 2¼d.
20	91.375	80.250d.	280.2860	250s. 1¾d.
23	91.375	80.250d.	280.2480	250s. 2d.
24	91.375	80.250d.	280.2540	250s. 1¾d.
25	91.375	80.250d.	280.2325	250s. 2¼d.
26	Holiday	80.250d.	Holiday	250s. 2¼d.
27	91.375	80.250d.	280.1600	250s. 2¼d.
30	91.375	80.250d.	280.1060	250s. 3d.
AVERAGES FOR MONTH				
Nov.	91.375	80.250d.	280.268	—
AVERAGES FOR WEEK				
Nov.				
4	91.375	80.250d.	280.448	—
11	91.375	80.250d.	280.290	—
18	91.375	80.250d.	280.276	—
25	91.375	80.250d.	280.266	—

Calendar Week Averages: New York Silver: Nov. 6, 91.375; Nov. 13, 91.375; Nov. 20, 91.375; Nov. 27, 91.375.

(c) The daily silver quotations reported by Handy & Harman, in cents and fractions of a cent per troy ounce, is the price paid by Handy & Harman in settlement for silver contained in unrefined silver-bearing materials submitted to them for refining. It is determined on the basis of offers of bar silver .999 fine as made to Handy & Harman for nearby delivery at New York by regular suppliers in quantities sufficient to meet daily requirements, and it is usually 0.250c below the price of which such offers are made.

The Treasury's purchase price of newly mined domestic silver is 90.5c per troy ounce 1000 fine effective July 1, 1946. London silver in pence per troy ounce, basis 999 fine.

(d) U. S. Treasury's gold price is $35. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

MARKETS (*Continued*)

London Metal Exchange Quotations

Nov.	Copper Cash Bid	Copper Cash Asked	Copper 3 Mon. Bid	Copper 3 Mon. Asked	Lead Current Month Bid	Lead Current Month Asked	Lead 3 Mon. Bid	Lead 3 Mon. Asked	Zinc Current Month Bid	Zinc Current Month Asked	Zinc 3 Mon. Bid	Zinc 3 Mon. Asked	Tin Cash Bid	Tin Cash Asked	Tin 3 Mon. Bid	Tin 3 Mon. Asked
2	252	253	242½	243	71¾	71⅞	72¼	72⅜	95¼	95⅜	91½	92	793½	794½	796	796½
3	252	253	242	243	72	72⅛	72⅛	72¼	95⅛	95⅜	91½	91¾	793½	794	795½	796
4	254½	255	244	244½	74⅛	74¼	73¾	73⅞	94¾	95¼	91	91½	793½	794	795½	796
5	259	260	247½	248	74⅜	74½	74	74⅛	93¼	93½	89½	90	793½	794	797	797½
6	259	260	247¾	248	74¼	74⅜	73⅝	73¾	93	93½	89½	89¾	794	794½	798	798½
9	265½	266	250	250½	73½	73¾	73	73⅛	96¼	96½	91¼	91½	794	794½	798	798½
10	266	266¼	250	250½	73½	73¼	73½	73¼	95½	95¾	90½	90¾	798½	799	802½	803
11	266	266½	251	251½	72⅞	72⅝	72¼	72⅝	96¼	96½	90½	90¾	798½	799	798½	799
12	259	259½	247	247½	71	71¼	71¾	72	96	96½	90	90½	798½	799	798½	799
13	258	258½	247	247½	70¼	70⅝	71⅜	71½	97¼	97½	90¾	90¾	797½	798	796½	797
16	255½	256½	243½	244	71⅝	71¾	72	72¼	95¼	95¾	90	90½	797½	798	795½	797½
17	248	248½	238	238½	72⅝	72¾	72¾	72⅞	95	95¼	90	90¼	797	797½	796½	797
18	247½	248	237½	238	73¼	73⅝	73¼	73⅝	94¾	95	89¾	90¼	797	797½	797	797½
19	245	245½	236	236½	72¼	72⅝	72¾	72½	94½	95	89¾	90	797	797½	796½	797½
20	241	242	235	235½	71½	71⅝	71⅞	72	93½	94	89	89¼	795	796	794	794½
23	236	236½	233	233½	70⅝	70¾	71⅛	71¼	92½	93	88¼	88½	792	792½	791	792
24	239½	240	235	235½	70⅞	71	71⅛	71⅜	92½	92¾	88½	88¾	787½	788½	787½	788
25	240½	241	236¼	236½	71⅛	71¼	71⅝	71⅞	94	94½	90¼	90½	792½	793	791½	792
26	237¾	238	234	234¼	70⅝	70¾	71¾	71½	94¼	94½	89½	89¾	794½	795	793½	794
27	237	237½	233½	234	71	71¼	72	72⅛	95¼	95½	90	90¼	797	798	793	794
30	236¾	237½	233½	233¾	71⅜	71¾	71¾	71⅞	95⅝	95¾	89⅞	90	794½	795	791½	792
Av'g's	£250.583		£241.381		£72.146		£72.390		£94.935		£90.179		£795.369		£795.726	

Prices are for the official a.m. session in pounds sterling per ton of 2240 lb. Copper basis wire bars, lead 99.9%, zinc 98% and tin min. 99.75%.

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipments, f.o.b. New York unless otherwise stated, tons of 2,000 lb unless otherwise noted. st—short ton; lt—long ton; stu—short ton unit; ltu—long ton unit. (p) duty paid.

MISCELLANEOUS METALS

Nov. 30, 1959

Aluminum ingot, 99 plus % lb		26.8c
Antimony, spot, lb, less than carload, in cases		32.59c
In bulk, carload lots, f.o.b. Laredo		29.00c
Imported, 10 ton min. (p), 99½%		24½c
Bismuth, ton lots, lb		$2.25
Cadmium, ton lots delivered, lb		$1.30
small lots		$1.40
Calcium, lb, ton lots, 98%, cast		$2.05
Chromium, 97% grade, lb, contract delivered		$1.29
Cobalt, 97 to 99%, per lb effective Feb. 1, 1957		$1.75
Germanium, per gram, 10,000 gram lots	(d) 33c —(c)	(d)35c
Indium, troy oz	$1.25 —	$2.25
Lithium, lb, 98%	$9.00 —	$11.00
Nickel, cathodes, lb (a)		74c
Other sales, regular sellers		74c
Sales by dealers, etc		74c
Magnesium, 99.8% carloads, lb producer's plants, Velasco, Texas, effective Apr. 16		35½c
Palladium, troy oz	$22.00 —	$24.00
Platinum, troy oz	$77 —	$80
Quicksilver, flask of 76 lb, 25 flasks or more	$215 —	$217
Selenium, 99 plus %, lb—(Feb. 19, 1958)		$7.00
Silicon, minimum 98%, carloads, lb		19c
Semi Conductor grade, lb		$360
Tellurium, lb		$2.50
Thallium, 100 lb or more		$7.50
Titanium, 99.3% plus, grade A-1, max. 3% Fe, lb (b)	$1.50 —	$1.60

(a) Effective Dec. 6, 1956; including U.S. duty; (b) Effective Aug. 1, 1959. (c) Delivered; (d) f.o.b. plant.

METALLIC ORES

Beryllium ore, imported, 10% BeO, (b) stu: spot		$31.75–32.50
term contracts		$34–34.50
Chrome ore per long ton, f.o.b cars Atlantic ports, dry:		
44% Cr_2O_3 no ratio	$17.50—	$18.00
48% Cr_2O_3 3 to 1 ratio	$34 —	$37
Iron ore, Lake Superior, Lower Lake ports, lt		
Old Range bessemer		$11.85(e)
Mesabi bessemer		$11.60(e)
Mesabi non bessemer		$11.45(e)
Lead (Galena), 80%, Joplin, Mo., ton		$156.12
Manganese ore—Per ltu of Mn basis 48%, nearby positions, subject to premiums and penalties, c.i.f. U. S. ports import duty extra., (n)87c—90c. Long-term contract nominal.		
Molybdenum ore, 90%, per lb of Mo f.o.b. mines		$1.25
Columbian-Tantalum, per lb, combined oxides 10 to 1 ratio	$1.10 —	$1.20
Tungsten ore, per stu of WO_3:		
Foreign 60%, c.i.f. U.S. ports, duty extra		$18
U. S. scheelite, f.o.b. mill	$22 —	$24
Vanadium ore, per lb of contained V_2O_5 f.o.b. mines		31c
Zinc ore, Prime, 60% concentrate, Joplin, Mo., per ton		$76

(a) Nominal. (b) c.i.f. U.S. ports. (e) Effective 1958 shipping season.

METALLIC COMPOUNDS

Arsenous oxide (arsenic trioxide) lb, in bbl, carload lots N. Y. docks		4–5c
Cobalt oxide, 72½% to 73½%, per lb, effective Dec. 1, 1956	$1.33 —	$1.36
Copper sulphate, 100 lb, effective Nov. 6, '59		$13.00
Germanium dioxide, gm		18½c
Molybdic trioxide, technical, per lb of Mo	$1.46 —	$1.47
Imported, including 37c duty	$1.75 —	$2.05

ALLOYS

Ferrochrome 65 to 70%, per lb of Cr, (4-9% C)		28¼c
Ferromanganese, 74 to 76%, per lb shipping point		12¼c
Ferromolybdenum, 58 to 64% Mo. Lb of Mo contained.	$1.50 —	$1.82
Ferrosilicon, 50% per lb of Si f.o.b. shipping point (3-1957)		14.60c
Ferrotungsten, 72 to 82%, lb of W contained		$2.15
Ferrovanadium, per lb of V delivered	$3.20 —	$3.40
Silicomanganese, max. 1½% c, lb contracts		12.8c
Spiegeleisen, per lt, 10—21% grade effective Jan. 7		$102.50

NONMETALLIC MINERALS

Asbestos, f.o.b. Canada (Quebec) mines (Canadian funds) ton:			
Crude No. 1	$1,400–$1,810	Paper Stock	$120–$145
Crude No. 2	$750–$1,155	Waste	$75– $86
Spinning Fibers	$370– $600	Shorts	$40– $75
Shingle fibers	$180– $220		
Asbestos, f.o.b., Vancouver, B. C. (Canadian funds):			
Crude No. 1	$1,522	Spinning fibers	$220–$787
Asbestos, Vermont, f.o.b. Morrisville:			
Spinning fibers	$370– $428	Waste, stucco or plaster	$86
Shingle stock	$181– $200	Refuse or shorts	$41– $75
Paper stock	$120– $152		
Barytes f.o.b. cars:			
Georgia, crude, per ton			$18
Missouri, 94%, $BaSO_4$, per st	$16 —		$18
Crude oil well grade, min. 4.3 sp gr, st (a)			$18
Imported, c.i.f. Gulf Ports, st	$16 —		$18
Bauxite, st. f.o.b. point of shipment:			
Domestic, crude, 50%, 8% Fe, 13% Si	$12.25 —		$13.50
Imported metallurgical, per lt, f.o.b. Br. Guiana, depending on grade			$7.14
Feldspar, bulk ton:			
Potash or soda feldspar, 200 mesh, ceramic grade	$20.50 —		$21
Glass feldspar, white, 20 mesh			$9
Fluorspar, f.o.b. mines, bulk, 72½% effective, ton	$37 —		$41
60% effective CaF_2	$33 —		$36.50
Acid 97% concentrate, bulk, ton (effective 12–1–56)			$50.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00 —		$14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington			$46

Mica—Domestic, f.o.b. mines. Punch 7c—12c per lb according to size and quality. Sheet clear 1½x2 in, 70c—$1.10; 2x2 in, $1.10 to $1.60; 2x3 in, $1.60—$2.10; 3x3 in, $1.80—$2.30; 3x4 in, $2.00—$2.60; 3x5 in, $2.60—$3.00; 4x6 in, $2.75—$4.00; 6x8 in, $4.00—$8.00. Wet ground, very fine, $140—$155 per ton. Bulk sales, dry ground; $30—$55 per ton. Scrap $20—$30.

Ocher Georgia, ton in sacks	$26.50 —	$32.00
Sulphur, long ton, U. S. producers' posted quotations*		
f.o.b. mines, bright		$23.50
dark		$22.50
f.o.b. vessel, bright		$25.00
U. S. ports, dark		$24.00

*Prices will vary from these depending on the competitive situation.

Current reports are that some sulphur sells for, f.o.b. vessel:		
bright	$21.50 —	$23.50
dark	$20.50 —	$22.50
Mexican, for use in Mexico, per metric ton, f.o.b. mines, 280 to 395 pesos, depending on location	$22.40 —	$31.60
For export f.o.b. vessel, lt, depending on grade	$20.00 —	$22.00
Talc, f.o.b. works, ton:		
New York, purified	$18.00 —	$20.00
Vermont, extra fine		$12.50
Tripoli, Missouri, ton:		
40-mesh, cream colored		$50.00

(a) Some restricted sales at $11.50. (b) Corrected. (c) Nominal.

IRON AND STEEL

Pig iron, gross ton, basic, Valley furnaces		$66.00
Steel, f.o.b. Pittsburgh, billets, net ton		$80.00
Structural shapes, Pa., Ala., etc., 100 lb	$5.30 —	$5.50

B.F.Goodrich

B.F. Goodrich tires carry 44-ton gross loads for strip miner, still can be retreaded twice

J. Robert Bazley, Inc. of Pottsville, Pa., strip mines throughout the anthracite region, also builds roads all over the state. The company operates 217 rubber-tired vehicles working as many as 70 hours a week. The truck above carries 22 tons of rock and dirt overburden. Add the vehicle weight, and you have a 44-ton gross load for those tires to carry over razor-sharp rock!

Yet the tires can be retreaded *twice!* This is possible because the tires are B.F.Goodrich Rock Service tires—specially built for this kind of work. Massive double-chevron cleats defy rock cuts and bruises, pull in forward or reverse. B.F.Goodrich FLEX-RITE NYLON cords withstand double the impact of ordinary materials, resist heat blowouts and flex breaks. Result: this B.F.Goodrich Rock Service tire body outwears even the extra-thick tread, can be retreaded again and again!

Follow the lead of successful strip miners like J. Robert Bazley. Switch to B.F.Goodrich Rock Service tires. You'll be dollars ahead. Your B.F.Goodrich Smileage dealer is listed under Tires in the Yellow Pages of your phone book. See him today. *The B.F.Goodrich Co., Akron 18, Ohio.*

Specify B.F.Goodrich tires when ordering new equipment

B.F.Goodrich *off-the-road tires*

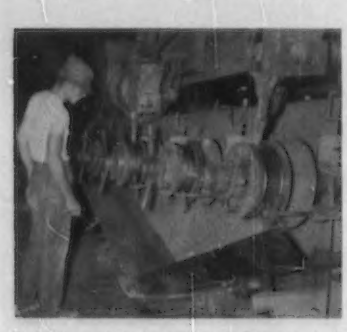
Increase the life of your wheels with S-D Hard-Faced Treads and Flanges...

"Modern mass-production equipment has catapulted Sanford-Day into the position of top mine wheel 'rehabilitation center' of the country."

—Fusion Facts

Why you save on S-D Hard-Faced Wheels (New or Reclaimed)

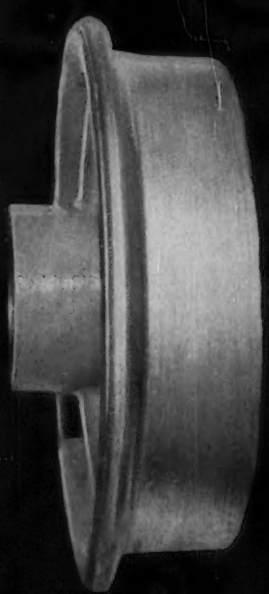
For years wheels like the one at right had to be discarded. Its (1) Tread and (2) Flange are "worn-out". But otherwise the wheel is as sound and serviceable as a new one. We have solved the problem of getting **wearing material** on a wheel where it does some good . . . **on the tread and flange where it is used!** We have reclaimed thousands upon thousands of "worn" wheels by successfully applying high alloy materials to the tread and flange of discarded wheels. These reclaimed wheels have earned such favorable savings, and due to oftentimes tripling their service life, many users have been ordering **new wheels** S-D Hard-Faced. They save the cost and down time of changing and reclaiming wheels when ordinary wheel flange and tread wear out.



Several completely automatic fixtures, such as this one, were developed at Sanford-Day in cooperation with the welding industry to mass-produce S-D Hard-Faced new wheels and reclaim old ones. Heads are shown here depositing high alloy on treads. A different alloy is used on flanges. Secret of long wheel life is obtaining wheels furnished with wearing surface on treads to take "impact", while wearing surface on flanges will take "scrubbing". S-D Hard-Facing assures you maximum and equal service of both tread and flange!

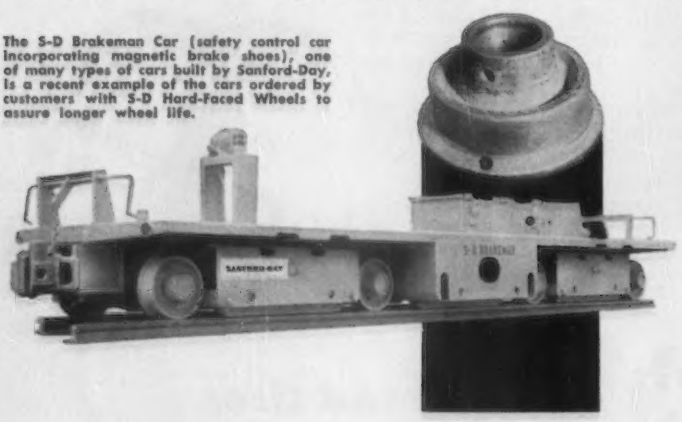
What counts is the proper alloy on the tread and flange! Over given period of time your wheel requirements will be reduced substantially when you order and use S-D Hard-Faced Wheels. Write us today for BULLETIN E-100 that furnishes complete information and specifications. **Sanford-Day Iron Works, Inc., P. O. Box 1511 . . . Telephone 3-4191, Knoxville, Tennessee.**

Worn wheel above shows typical condition of wheels formerly discarded. Field reports and customer experiences with S-D Hard-Faced Wheels show that reclaimed wheels, like one below, often give three times the service life of unprotected ones at far less than new part cost.



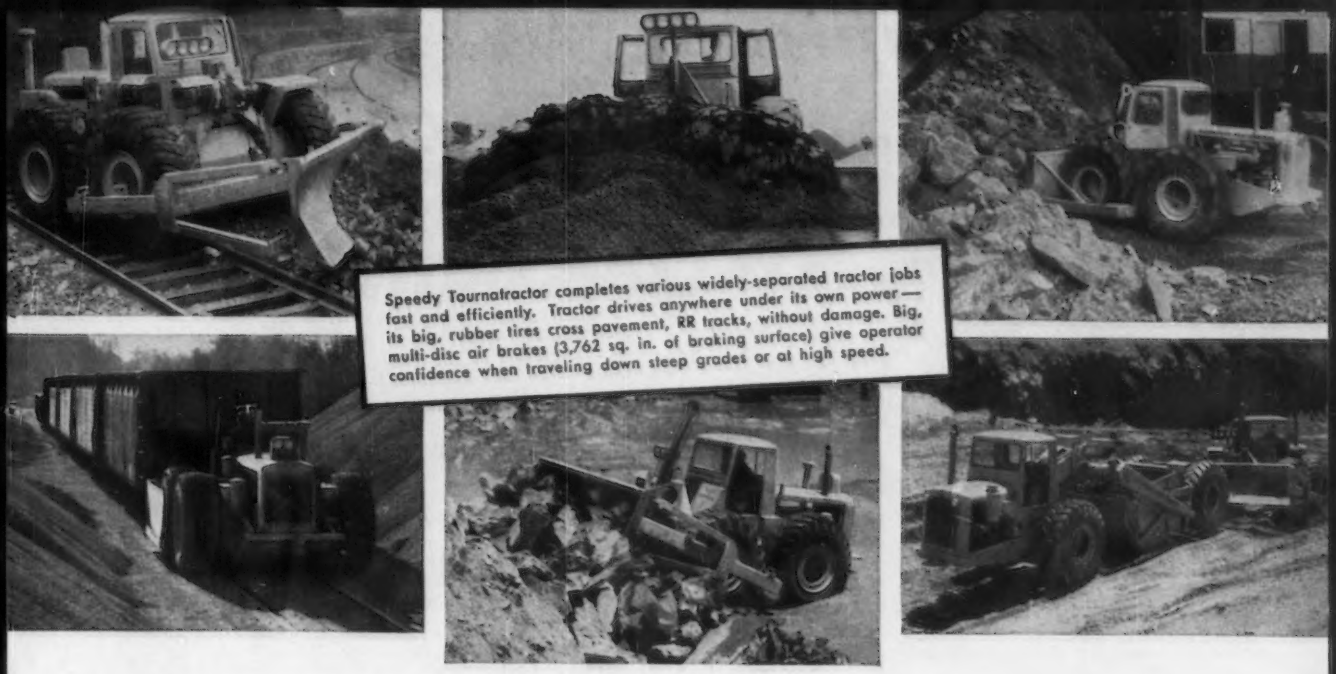
Pictured below is a test wheel after many months service in severe service. It shows no appreciable wear on the S-D Hard-Faced tread and flange.

The S-D Brakeman Car (safety control car incorporating magnetic brake shoes), one of many types of cars built by Sanford-Day, is a recent example of the cars ordered by customers with S-D Hard-Faced Wheels to assure longer wheel life.



SD SANFORD-DAY

KNOXVILLE, TENNESSEE



Speedy Tournatractor completes various widely-separated tractor jobs fast and efficiently. Tractor drives anywhere under its own power — its big, rubber tires cross pavement, RR tracks, without damage. Big, multi-disc air brakes (3,762 sq. in. of braking surface) give operator confidence when traveling down steep grades or at high speed.

A "sure-fire" way to CUT PIT COSTS

When modernizing your pit operations, don't overlook the savings you can make by replacing 2 or more slow-moving track-type tractors with a fast, rubber-tired tractor, to handle your scattered pit and road clean-up. This *one* speedy tractor can complete the same (or more) assignments — without need for extra machines and operators.

These "sure-fire" savings are possible with a fast, rubber-tired LeTourneau-Westinghouse Tournatractor®.

1. One L-W tractor can often replace 2 to 3 crawlers, cutting your cost for operating and maintenance, fuel, and spare parts.

2. Between pit chores, your fast, rubber-tired tractor can handle haul-road maintenance and drainage problems. Good haul roads help to lower your hauler repair costs... keep these production units rolling fast and safely, to complete more cycles per hour.

3. Mobile, 218-hp Tournatractor easily drives to new areas of operation under its own power, at speeds to 17.2 mph. It goes right to work to clear land, strip overburden, build access roads. Rubber-tired tractor needs no flatbed trailer, truck, and extra manpower to load and transport unit to remote operations.

4. Cleans-up around plant area, dresses and seals stockpiles, eliminates excessive waste.

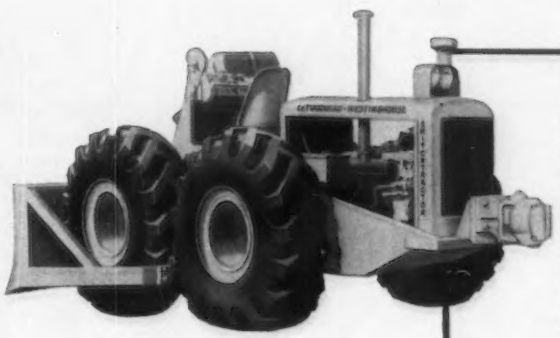
5. Tournatractor spots rail-cars, tows equipment — reduces costly time waiting for switch engines.

6. In winter, with V-type snow plow, L-W tractor plows snow from roads, loading and dumping areas — keeps pit operations open and safe in all kinds of weather.

Every tractor assignment — anywhere on your property — can be handled quickly and efficiently by versatile Tournatractor. And, if your pit normally sidelines equipment during its off-season, this mobile L-W tractor can be rented out to nearby pits, contractors, counties, or municipalities. It's easy to keep Tournatractor busy all year long!

Try it in your pit

Let us demonstrate a LeTourneau-Westinghouse Tournatractor in your pit. Write or phone for complete information. No obligation.



Standard Type E railway car coupler is one of 10 Tournatractor attachments available to help you cut tractor costs. With coupler, this powerful off-track switcher spots and groups rail-cars fast. Big, rubber-tired wheels on SwitchTractor† straddle rails, ride on ballast and tie-ends — deliver double the tractive effort of steel-wheeled switchers on steel rails.

†Trademark CT-1811-MQ-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

—— Make a "spec check"...

Compare Haulpak® ...see how

LW engineers "threw away the book" when they designed the new Haulpak off-road hauler... for *your* benefit. Some of the exclusive features that resulted are shown here. They are advantages that help you move *more* tonnage, *faster*, at *lower* net cost per ton.

To see what this advanced design approach means to Haulpak, check its specifications. You'll want "spec sheets" in your files anyway, and your LW Distributor can supply you copies. Then, with basic Haulpak facts handy, compare them to *other* off-road haulers.

WHAT YOU WILL FIND WHEN YOU COMPARE HAULPAK:

(Competitive hauler specifications are "averaged out" for simplicity purposes... but Haulpak superiority is just as clear over any *single* machine.)

WHAT TO COMPARE	Off-road Haulers 20-30-ton class		Off-road Haulers 30-40-ton class		HOW YOU BENEFIT
	Average*	Haulpak LW 27	Average*	Haulpak LW 32	
Length Wheelbase Turn Diameter	26'7" 14'4" 64'3"	23'10" 10'10" 44' 6"	31'5" 16'7" 77'6"	23'10" 10'10" 44' 6"	*HAULPAK is shorter.* You maneuver faster, quicker and in less space.
Top Speed (in mph)	30.7	35.4	25.2	38.8	*HAULPAK is faster,* for more cycles per hour, more tonnage per shift.
Empty Weight (in lb)	49,300	43,020	73,400	44,950	*HAULPAK is lighter,* for more payload weight, less "dead" weight.
Ground Clearance Front Axle Rear Axle	16" 16"	25" 20"	17¼" 18½"	25" 20"	*HAULPAK has higher* clearance, to minimize troublesome "dozing" action.
Brake Surface (sq inches)	1511	4680	1834	5148	*HAULPAK has bigger* brakes, for greater safety, more steady use of high speeds.

and here are some of the design features that make these HAULPAK advantages possible

(*Based on specifications available at time of printing)

Where quality is a habit

All new . . . but Haulpak is already a fully-proven piece of equipment. Units worked for over 14 months on construction jobs, in mines, and in quarries, before the first Haulpak was put on the market. Exceptional results of these tests are now being duplicated all around the nation.

it can cut your haul costs

Hydrair* suspension...eliminates springs...permits higher clearance, shorter turns

Haulpak rides on air! 4 Hydrair units replace leaf springs. System cushions against loading and travel shock, reduces maintenance costs. Eliminates front axle, and compensates for off-center load. *COMPARE IT!*

"V"-shaped body...lets Haulpak outcarry trucks that are longer, higher, heavier

Bonus yardage in every Haulpak load rides in exclusive V-bottom of body. Slope also helps fill all corners for low-void payloads. "V" lowers center of gravity for better stability, traction, on grades. *COMPARE IT!*

Box-beam frame...3 times stronger, ⅓ lighter, carries 30% more payload weight

Strongest hauler body ever built. Floor and all wear-surfaces made of 10,000 psi steel, yet weighs 33% less than comparable bodies. Body is exhaust-heated. Haulpak hauls 30% more than its own total weight. *COMPARE IT!*

Available in 22, 27, and 32-ton capacities

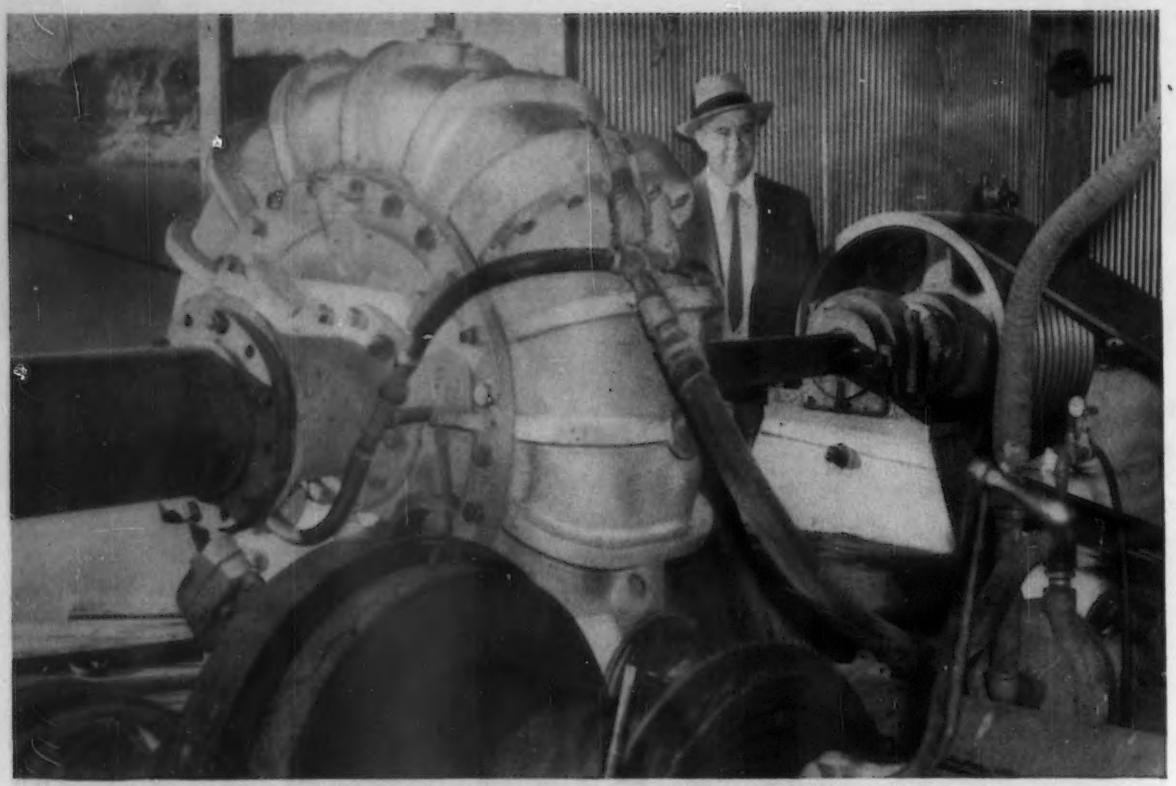
PLUS: MINIMUM MAINTENANCE (entire lube-check, needed only at 500-hr intervals, consists of just 4 easy-to-reach grease fittings) . . . POWER-TRANSFER DIFFERENTIAL (famed Tournapull® feature which automatically transfers power to wheel on best footing when going is rough) . . . POWER-MISER FAN (cools with 20 to 25 less hp drain) . . . 100% RUBBER-MOUNTED BODY (absorbs impact and shock of loading) . . . FOUR SEPARATE BRAKING SYSTEMS (for fast stops with complete safety) . . . POSITIVE POWER STEER (for faster turning, easier handling) . . . SIMPLE SIX-GEAR FINAL DRIVE (compared to 12 or more usually standard) . . . BIG, ROOMY CAB (has many work-efficiency features).

*Trademark HP-2193-DC-2

LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit



This dredge, operated by a prominent sand and gravel producer in Kansas, is equipped with a highly successful Thomas Ni-Hard pump installation.

Dredgers report Ni-Hard alloy pumps outwear others 4 to 6 times

From state after state come reports of the extraordinary service life of Thomas Ni-Hard pumps, made by Thomas Foundries, Inc., Birmingham, Alabama.

A West Virginia sand and gravel producer, for example, reports, "Since 1953, we have used only two Ni-Hard shell liners . . ."

A New Jersey company formerly replaced parts every 2 to 3 weeks . . . now says, "Today, we get approximately a year's service . . . a lifesaver."

From Nebraska: — ". . . after almost two years of pumping has required no repairs, major or minor."

From Arkansas: — ". . . by far the most efficient and economical pump we have ever used, our 40-year records prove."

From these reports, it's easy to see that *longer pump life means lower operating costs!*

And a large part of the credit for the outstanding durability of Thomas Pumps goes to Ni-Hard* nickel-chromium cast iron.

This alloy is the most abrasion resistant of all commonly used cast materials, out-lasting many 4 to 6 times . . . regularly outwearing manganese steel in pump service.

What's more, Ni-Hard alloy has demonstrated remarkable impact resistance . . . being widely used for drop balls, crusher linings, and for many other severe applications. In impellers, casings, linings, and other parts for pumps, Ni-Hard alloy has virtually eliminated cracks or impact erosion caused by gravel and rocks.

If severe wear is running up your operating costs — it will pay you to find out what Ni-Hard alloy can do. Inco's booklet, "Engineering Properties and Applications of Ni-Hard" gives you essential details, and Inco's "Ni-Hard Buyers' Guide" lists authorized producers throughout the country. Write us for your free copy.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N.Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

JOY HAS THE RIGHT SLUSHER FOR THE JOB

Model No.	Horsepower
S-211	5 hp
FF-211 & FF-311	7½, 10, 15 hp
A2F-211 & A2F-311	15, 20, 25 hp
B2F-211 & B2F-311	20, 25, 30, 40 hp
C2F-211A & C2F-311A	50, 60, 75 hp
R-221 & R-222	100, 125 hp
RF-211-212	100, 125 hp
XT-221 & XT-222	150 hp

With a complete line of job-rated slushers, Joy can recommend the proper unit to do the job efficiently. For true economy on the small jobs, Joy offers the S-211 and FF-211 line in sizes from 5 to 15 horsepower. These units are air or electric driven and extremely compact for portability underground.

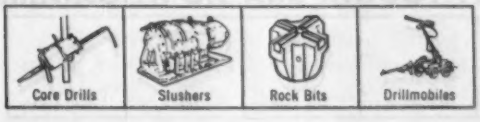
For medium capacity, Joy builds A and B class slushers from 15 to 40 hp. These two and three drum slushers are designed to handle the bulk of scraping jobs.

Three larger units in the "C" series go up to 75 hp for the heavy-duty jobs where portability is still required. For the largest semi-permanent installations, Joy builds large capacity slushers from 100 to 150 horsepower.

With more than 300 types and sizes of hoists and slushers to choose from, there is not a scraping job that can't be handled most efficiently with a Joy unit. Call in a Joy engineer for the size and type to suit your scraping jobs or write for bulletin 950-4.

EQUIPMENT FOR MINING...FOR ALL INDUSTRY

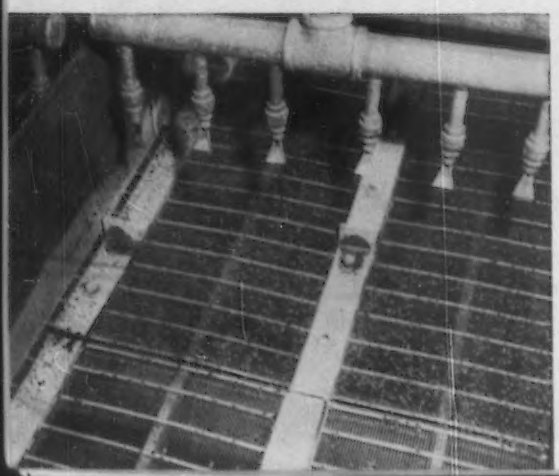
JOY



Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

USS "T-1" Steel dipper weighs 5 tons less, scoops 10% more load. This shovel originally had a 30-cu.-yd. dipper (90,000 pounds capacity) that weighed 57,650 pounds. It was replaced with a 33-cu.-yd. (99,000 pounds capacity) dipper made of USS "T-1" Constructional Alloy Steel that weighs only 46,900 pounds—a clear saving of 10,750 pounds of steel. The new dipper has a capacity gain of 10%, or 9,000 pounds; yet its total weight, including load, is nearly one ton less than the old unit. "T-1" Steel is a natural for dipper and bucket construction. It has tremendous yield strength (100,000 psi min.), weldability and exceptional resistance to impact abrasion. This dipper was built by Bucyrus-Erie for use in the Red Ember Mine of the Truax-Traer Coal Co. near Fiatt, Illinois. Mr. Roy Leseney, Mechanical Superintendent of the mine, says that "T-1" Steel dippers are doing a marvelous job for them. They dig better, handle easier and last much longer than dippers previously used.



Stainless Steel? You can hardly wear it out! That's what John Robinson, Chief Foreman at the Truax-Traer Burning Star Mine says about the USS Stainless Steel used in vibrator screens, liners and chutes. The old iron screens wore out in 6 months but these stainless vibrator screens have been in for 30 months with little signs of wear. Another big advantage is that fine, wet coal doesn't stick on stainless steel. No cleaning at all has been necessary—an obvious saving in time, labor and money.

How Truax-Traer reduces mining costs with USS Special Steels

One sure way to reduce mining costs is to use stronger, brawnier steels that can take pounding, rough handling, and constant abuse. At Truax-Traer mines, USS High-Strength Steels, extra strong "T-1" Constructional Alloy Steel and Stainless Steel are very much in evidence. These special steels are boosting service life, increasing payloads, reducing downtime and saving operating dollars.

Here are the USS Steels that do more —and save more:

USS MAN-TEN Steel—High strength with abrasion resistance and economy. (Minimum yield point 50,000 psi)

USS COR-TEN Steel—High strength with superior atmospheric corrosion resistance and abrasion resistance. (Minimum yield point 50,000 psi)

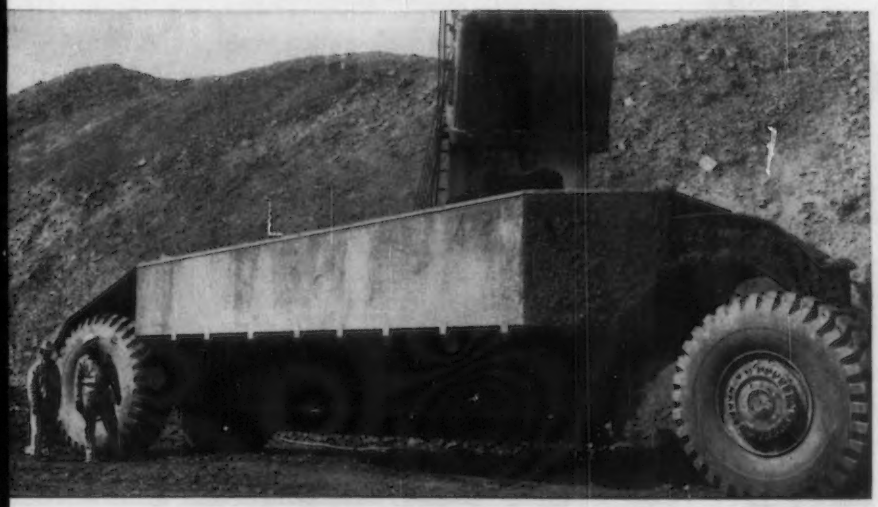
USS TRI-TEN Steel—High strength with toughness, weldability and abrasion resistance. (Minimum yield point 50,000 psi)

USS "T-1" Steel—Super strength with impact abrasion resistance, weldability and toughness. (Minimum yield strength 100,000 psi)

USS STAINLESS Steel—High resistance to corrosion, elevated temperature and abrasion.

Each of these USS Steels is superior for certain applications. Our metallurgists will help you choose the best steel for your job. Contact our nearest sales office or United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS, COR-TEN, MAN-TEN, TRI-TEN, and "T-1" are registered trademarks

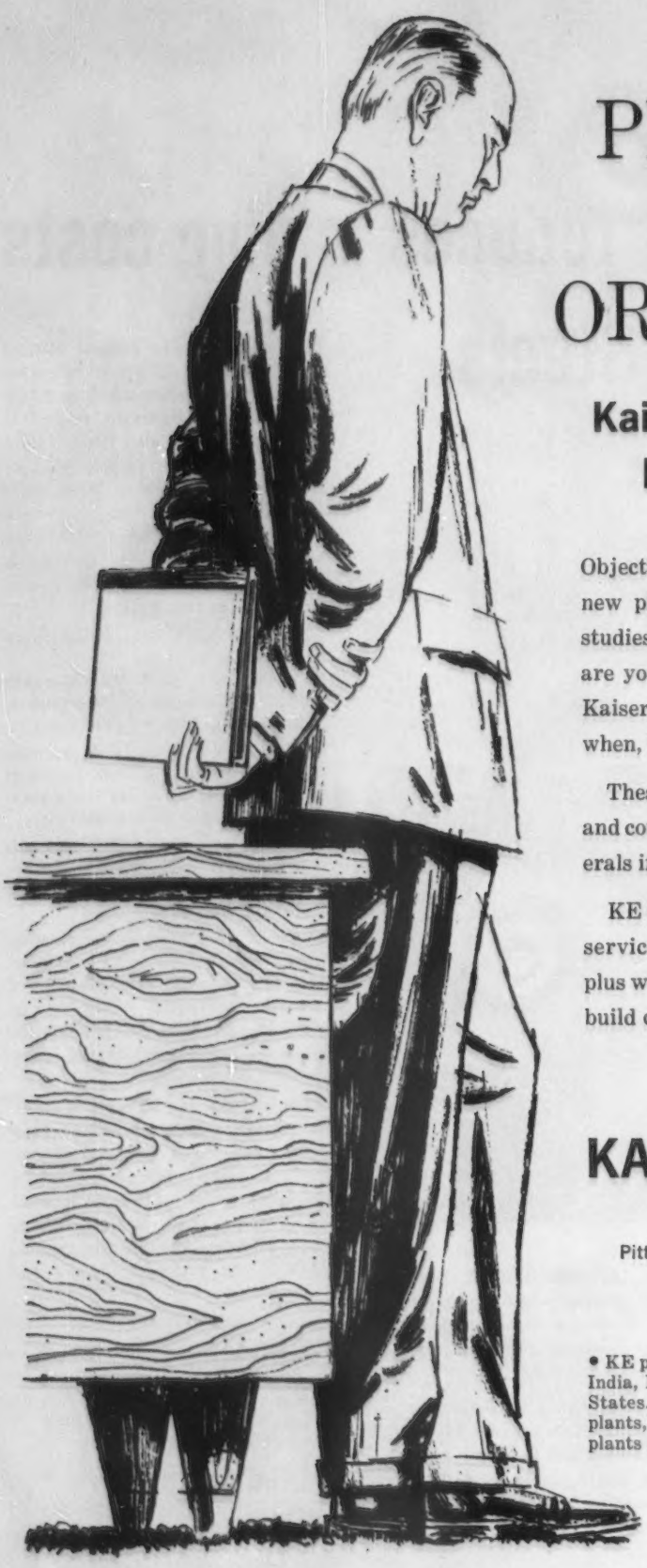


60-ton high-strength steel trailer replaces three 20-ton units. Four of these giant Euclid trailers haul coal between the stripping operations and the tipple at Truax-Traer's Burning Star Mine #1 near Elkville, Illinois. Each one does as much work as three of the 20-ton units previously used—with a big saving in operating costs.

To get maximum capacity with low weight and low maintenance, the designers used two USS High-Strength Steels, COR-TEN and MAN-TEN brands. These steels have great ability to take shock, abrasion and wear and COR-TEN steel offers 4 to 6 times the atmospheric corrosion resistance of carbon steel. The trailers have been in use 6 months and no maintenance has been necessary.

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel



PROCEED, DEFER OR MODIFY?

Kaiser Engineers can help you decide

Objective analysis is vital to sound decision on new plant or expansion projects. Feasibility studies, economic analyses and site evaluations are yours by an outside, impartial firm when Kaiser Engineers is selected to help you decide when, how and where to proceed.

These services are in addition to the design and construction of major facilities for the Minerals industry.

KE offers complete, one-company, integrated service from concept through construction—plus world-wide experience and the ingenuity to build quickly, within budget.

KAISER ENGINEERS

Division of Henry J. Kaiser Company
Oakland 12, California
Pittsburgh, Washington, D. C., Chicago, New York

• KE projects include work in Australia, Brazil, Ghana, India, New Zealand, as well as Canada and the United States. Assignments include iron ore concentrating plants, cement plants, bauxite and alumina processing plants and diatomaceous earth facilities.

5458-M

As shale is dumped on the grade, the 4-in-1 instantly changes from big-capacity loader to material-moving bulldozer. The operator simply lifts the clam lip, hydraulically, to switch machine actions. He regulates dozing depth with positive accuracy, using "radius control" of blade. It takes a bonafide, full-size standard dozer to match this capacity!

"Back-Dragging" with exclusive clamshell action, the 4-in-1 reduces time and cost of "dressing" a bank and pulling down "slide" rock. TD-20 shuttle-bar control speeds up back-and-forth cycles on jobs like this. Using clamshell in this position also permits speedy pick-up of stumps or loose materials that give straight buckets trouble.

"Our TD-20 Four-in-One does jobs impossible for regular dozer or loader"

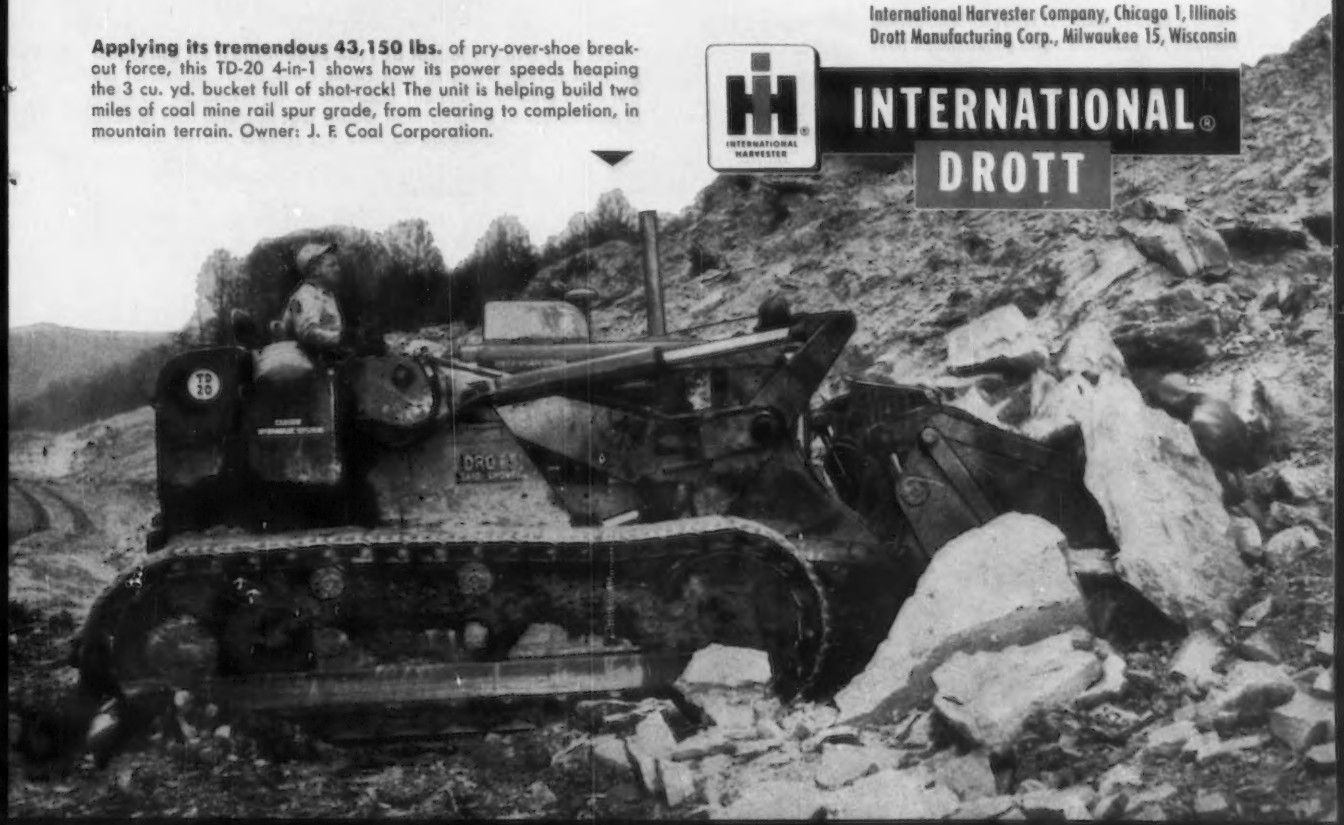
—J. F. Coal Corporation, Summersville, W. Va.

"We have used the 4-in-1 for practically all phases of this work, often doing jobs impossible with regular dozer or loader," reports Russell Patrick, Manager, J. F. Coal Corporation, Summerville, W. Va. Prove to yourself what it means to get four-machine utility—bulldozer, excavator-loader, clamshell, "carry-type scraper"—for one moderate investment. See how this "one-man equipment fleet" cuts operating cost and machinery investment—increases profit. Measure the performance-protection plus value of exclusive, shock-swallowing Hydro-Spring. See your International Drott Distributor for a 4-in-1 demonstration!

International Harvester Company, Chicago 1, Illinois
Drott Manufacturing Corp., Milwaukee 15, Wisconsin

Applying its tremendous 43,150 lbs. of pry-over-shoe breakout force, this TD-20 4-in-1 shows how its power speeds heaping the 3 cu. yd. bucket full of shot-rock! The unit is helping build two miles of coal mine rail spur grade, from clearing to completion, in mountain terrain. Owner: J. F. Coal Corporation.

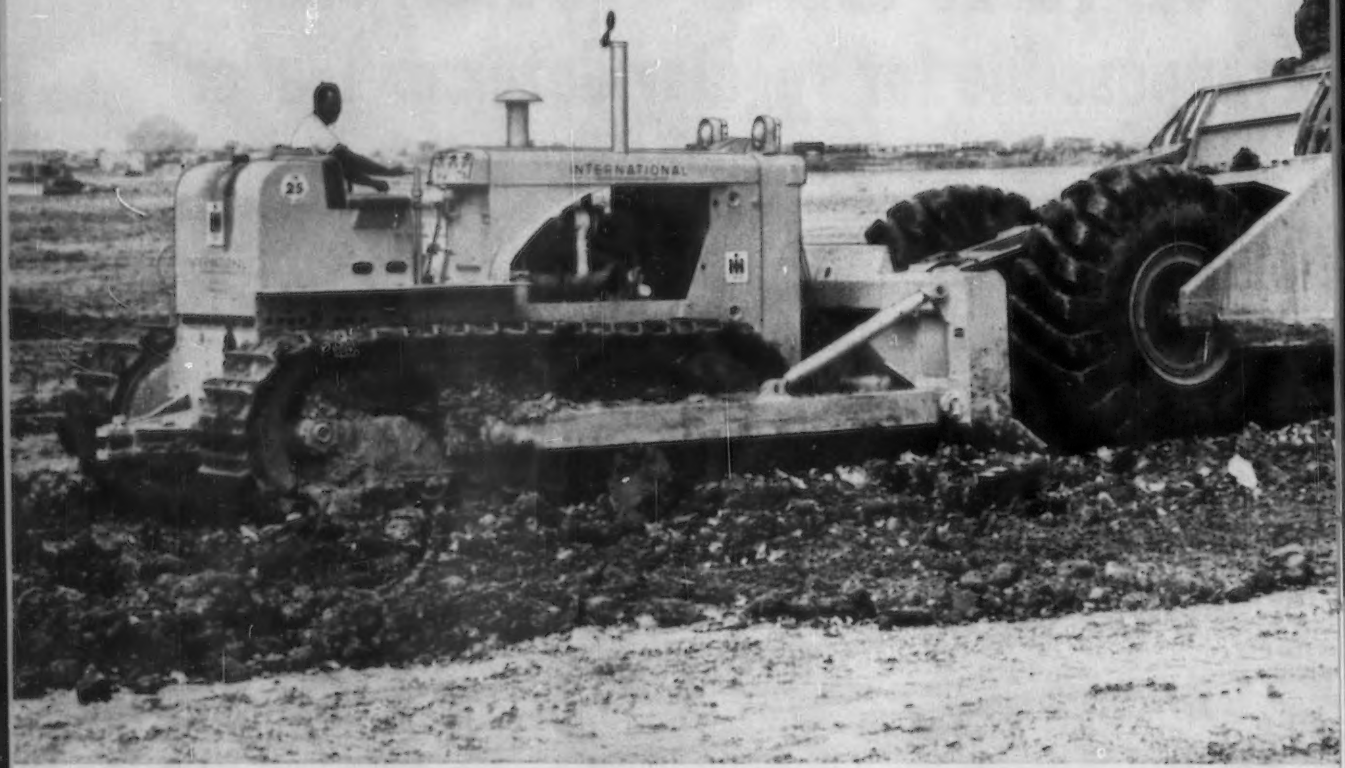
INTERNATIONAL® DROTT

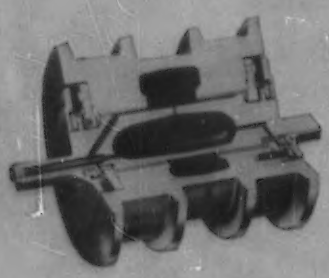


TD-25 power-steering plus

team new 230 diesel hp, new traction..

You "gain ground" on all four steps of the push-loading cycle with the torque-converter TD-25. (1) you slow-down by power-shifting down and using decelerator to get feather-touch contact; (2) power-shift either track up or down to maintain solid pusher contact on curves; (3) get gear-higher kick-outs with on-the-go power-shifting; (4) reposition faster, with higher-than-ordinary reverse!





Dual-protected TD-25 Dura Rollers have precision-fitted, metal-to-metal cartridge-type sealing—to exclude abrasives and retain lubricant. These rollers have pressure relief passages so they can be power-lubricated—without affecting seal life or efficiency. Dura Rollers have king-size lube reservoirs, to make twice-a-year lubing practical!

on-the-go Hi-Lo power-shifting

...to outearn other rigs up to 50%!

You Power-Steer and Power-Shift the new International TD-25, with 2-finger ease! Exclusive, years-proved Planet Power steering gives you full-time "live-track" power and traction to make full-load turns and eliminate "dead-track drag." Hi-Lo on-the-go power shifting instantly matches power to conditions to prevent losing momentum!

Exclusive Efficiency-Range Control

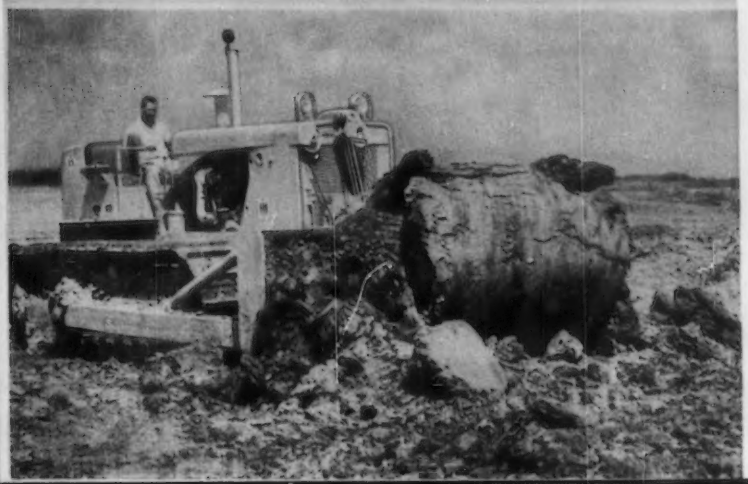
Exclusive International Hi-Lo power shifting makes the TD-25 the industry's only 4-speed torque-converter crawler, and the only one with load-matching, efficiency-range control. In the synchro-mesh transmission TD-25, the Hi-Lo planetary system gives eight speeds forward and reverse—with cycle-speeding up-or-down, on-the-go shifting!

You get big-capacity teamwork of 230 diesel horsepower with the new 7-roller tracks, platformed on super-rugged, double-box-beam frames—and carried on International's new minimum-maintenance Dura Rollers! Over 39 square feet of ground-gripping traction area harness the "25's" great power!

You simply press the direct-start button, to command the "25's" free-breathing diesel horsepower. Dual valving of the "25's" high-torque DT-817 engine provides for peak turbocharging efficiency—to deliver full-rated power from sea level to timberline!

Full performance is at your fingertips, full time. No wonder the TD-25 outearns same-sized clutch-steered crawlers up to 50%—on a wide range of tough jobs!

You don't spill the "pay" part of your load with the TD-25—even when you change speed making the "pass." Hi-Lo on-the-go planetary shifting keeps the blade fully loaded—even when dozing round curves, benching, or side-casting! See how the "25" can help you pocket bigger profits.



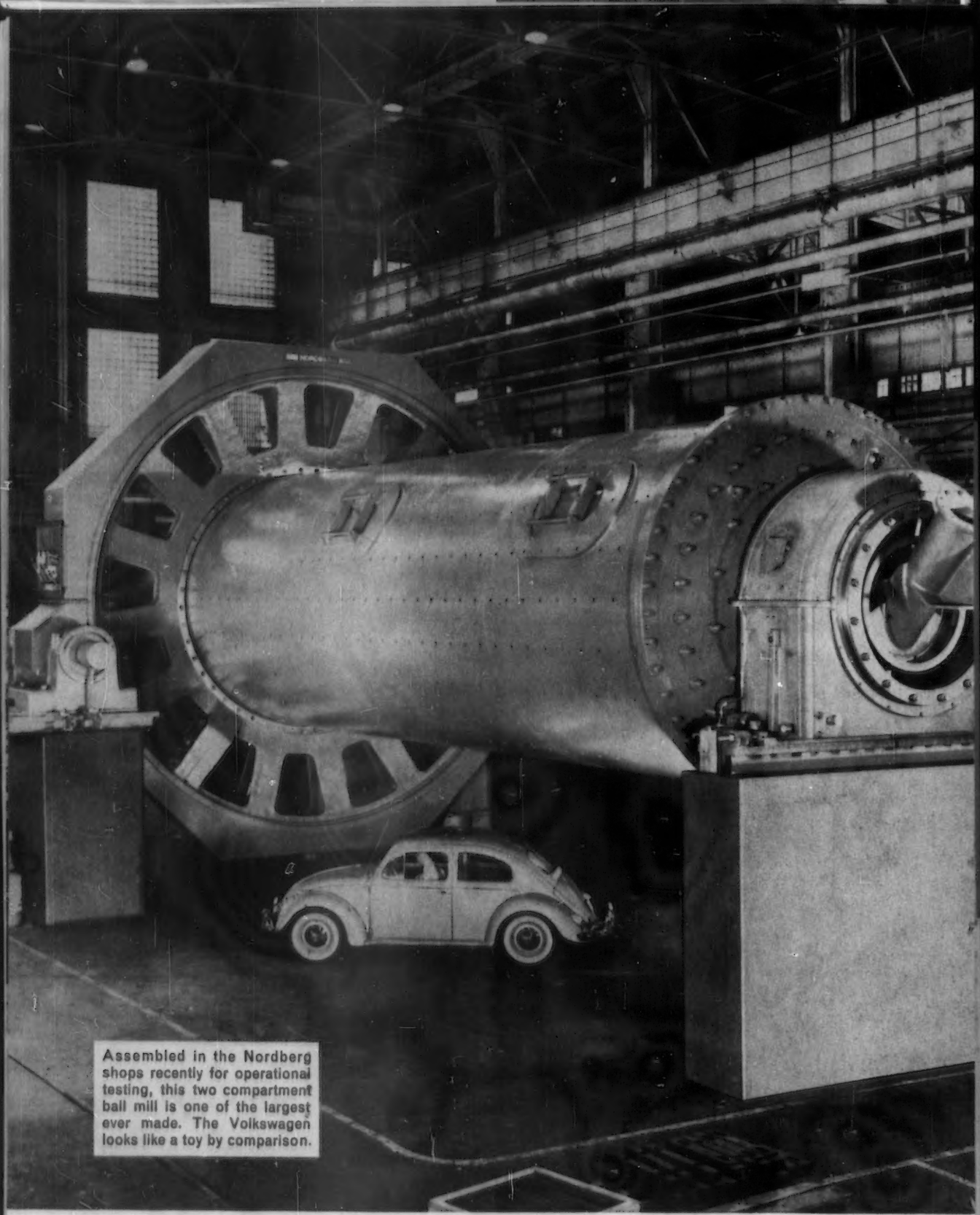
SIZE UP TD-25 PLANETARY DRIVE DESIGN that breaks the load-limiting, time-losing steering and shifting bottlenecks—which plague king-sized, clutch-steered crawlers.

COMPARE NEW TD-25 FULL-LOAD, FULL-TIME ABILITY, to outearn other same-sized rigs—up to 50%! Let your International Construction Equipment Distributor demonstrate!

International® Construction Equipment

International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill.

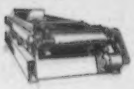
A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers and Bottom-Dump Wagons . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.



Assembled in the Nordberg shops recently for operational testing, this two compartment ball mill is one of the largest ever made. The Volkswagen looks like a toy by comparison.

SYMONS PRIMARY GYRATORY CRUSHERS

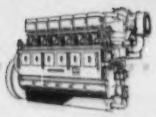
SYMONS® CONE CRUSHERS



SYMONS VIBRATING SCREENS

SYMONS VIBRATING GRIZZLIES

ROTARY KILNS and COOLERS



NORDBERG ENGINES

NORDBERG sets the pace in LARGE GRINDING MILLS

to turn out greater tonnages at lower cost per ton

Nordberg has recently completed five of the largest grinding mills ever built for industrial service. These two compartment Nordberg ball mills (see opposite page) are 12 feet in diameter by 36 feet long, each powered by a 2500 hp synchronous motor, operating at 10% beyond rating. These mills are being installed in a new 5 million barrel per year wet process cement plant. The economies of using very large grinding mills to turn out greater tonnages at lower cost are important, however, to many other large ore and mineral reduction processes, as well.

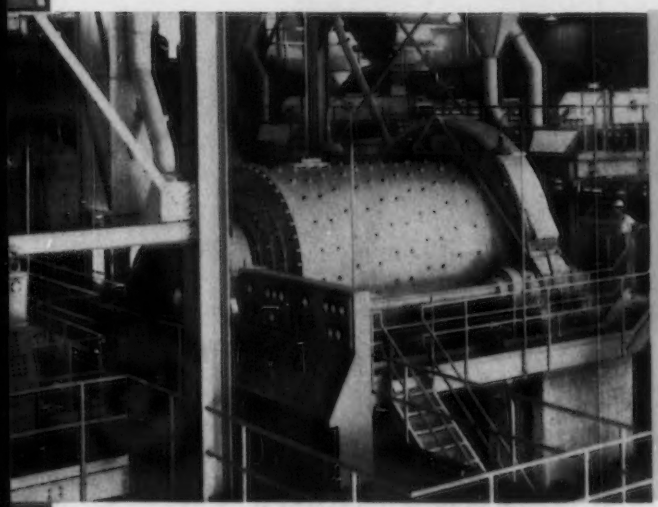
Consider some of these basic advantages:

1. *Lower construction and installation costs* . . . A single, large mill requires less floor space than several smaller ones, and only one foundation is required. Thus, construction costs are lowered and, in most cases, production is increased.

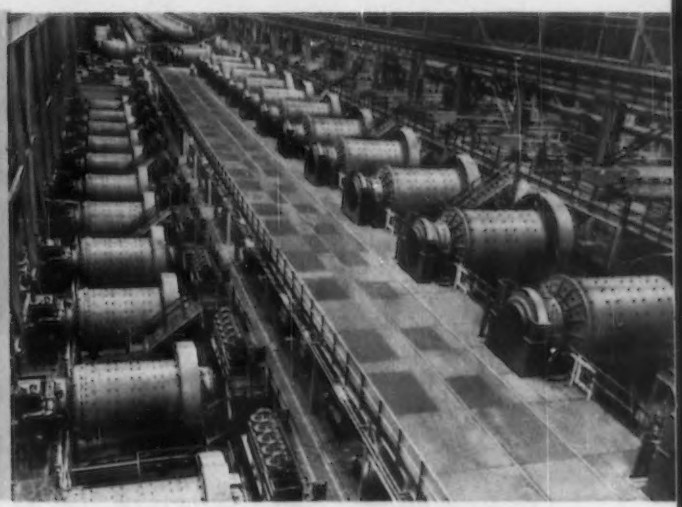
2. *Simpler automatic operation* . . . Where automatic operation is required, larger mills permit simpler handling with fewer controls. This lowers initial investment and minimizes installation and operational problems of automatic controls.

3. *Less maintenance* . . . Here, costs are again related directly to the number of mills installed. Fewer units mean less wearing parts and more dependable production. Exceptional savings may also be realized in replacement liners alone.

These are significant reasons behind the current trend toward larger grinding mills. But whether you require large or small grinding mills, you can count on the proven experience of Nordberg in furnishing the right grinding mill to meet your specific needs . . . including Rod, Ball, Pebble, Tube and Compartment types, in sizes from 6 to 13 feet in diameter and up to 50 feet in length. *Write for further information.*



Shown here are two of five 11′ x 17′ Nordberg Ball Mills—three raw and two finish—installed in a midwest cement plant that has a capacity of 3,000,000 bbl. annually.



The largest iron ore mill installation in the world with 58 Nordberg Grinding Mills. This concentrator building houses 27, 10′ x 14′ rod mills and 27, 10′ x 14′ ball mills. Four Nordberg mills serve as standby units.

NORDBERG MANUFACTURING COMPANY, Milwaukee 1, Wis.

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NORDBERG

SYMONS . . . a registered Nordberg trademark known throughout the world.

SYMONS SCREENS NORDBERG

ATLANTA · CLEVELAND · DALLAS · DULUTH · HOUSTON · KANSAS CITY · MINNEAPOLIS · NEW ORLEANS · NEW YORK · ST. LOUIS
SAN FRANCISCO · TAMPA · WASHINGTON · TORONTO · VANCOUVER · JOHANNESBURG · LONDON · MEXICO, D. F.

"I call Bethlehem when I need track spikes fast. They carry all standard sizes in stock, ready to go at a moment's notice."

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

These exclusive features of the new

Cleaner, cooler operation . . . less maintenance . . . longer, trouble-free life

HERE'S WHY: Ordinary d-c motor ventilation systems draw air in at the commutator end, contaminate windings by drawing carbon dust from commutator brush wear *into* the machine. In the new Life-Line® "H," this air flow is reversed. Air and carbon dust are expelled at commutator end . . . assuring cleaner, cooler windings . . . longer motor life . . . less maintenance.

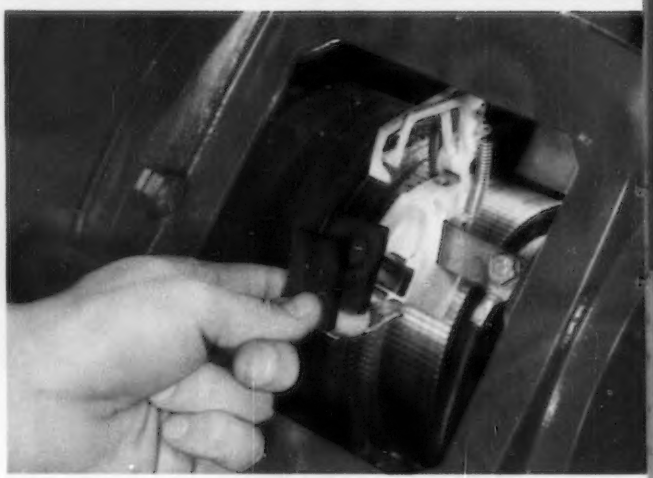
Plus . . . these other important advantages .....

YOU CAN BE SURE...IF IT'S Westinghouse

These exclusive features of the new Westinghouse Life-Line H d-c motor guarantee top performance . . . longer, trouble-free life

TEN TIMES LONGER INSULATION LIFE . . . New silicone insulation in Westinghouse Life-Line® "H" d-c motors and generators stands up under temperatures which turn ordinary insulation to a cinder. High-temperature silicone insulation is used with the full complement of iron and copper required for low Class B temperature. Result: Life-Line "H" shrugs off emergency overloads and abnormal ambients to keep production rolling, maintenance down.

GREATER PROTECTION . . . most complete and advanced protection available in dripproof industrial d-c machines. Elimination of uncovered side openings . . . heavy, cast end brackets . . . effective seals throughout . . . all combine to provide outstanding resistance to liquids, vapors and dirt. This means longer life with greater reliability . . . minimum maintenance under all operating conditions.



FASTEST RESPONSE . . . 35 per cent increase in commutating ability . . . up to 55 per cent lower mechanical inertia . . . and up to 30 per cent reduction in electrical inertia mean that the new Westinghouse Life-Line "H" d-c motor provides the fastest acceleration, quickest reversing and closest speed regulation. This means more production, better product quality, minimum complexity of control.

SIMPLIFIED MAINTENANCE . . . With the new Life-Line "H," maintenance is not only substantially reduced but periodic inspections are also greatly simplified. For example: as shown above, Uniforce brushholder fingers lock out . . . brushes can be inspected or changed with one hand. And Uniforce tension remains constant throughout brush life . . . no need to adjust pressure as brushes wear.

For information about the ways you can profitably put the new Life-Line "H" motor to work, contact your nearby Westinghouse representative. Or, write Westinghouse Electric Corporation, P. O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa. J1-22122

YOU CAN BE SURE...IF IT'S Westinghouse

NEW PRODUCTS DIGEST

Plastic Relief Maps Announced

A NEW SIZE SERIES of plastic relief maps has been developed by Aero Service Corp. aimed at the general public for home and office use. Map size is 28x18 in. in sturdy plastic that can take considerable abuse and is printed in eight colors. A feature of the series is the Slide-O-Map index which pulls out of the back of the map, and which indexes and locates all the name places. Aero's cartographers believe the smaller (and inexpensive) size will find wide acceptance. Two maps in the series have been released in time for the last minute Christmas rush: one of the U.S. and one of the world. U.S. map is an up-to-date, 50-state counterpart of the larger (60x40 in.) U.S. map released several years ago. Scale is 1 in. equals 117 miles. Map shows over 2,000 cities and towns, nearly 1,000 rivers and lakes, and 150 national parks and monuments. Over 200 mountain ranges and peaks (vertically exaggerated) illustrate the

U.S. terrain. The map of the world is scaled 1 in. equals 962 miles and shows 2,500 name places, including 1,200 cities. Maps have a simulated wooden frame and are ready to hang. Write direct to Aero Service Corp., 210 E. Courtland St., Philadelphia 20, Pa. Price of either map is $9.95, plus 50¢ postal charges.

Cartoons Stress Tractor Maintenance (2)

A SERIES of cartoons, pointing up the importance of preventive tractor maintenance, is offered free to owners and operators of earthmoving equipment. Printed in four colors on heavy paper, the 11x13-in. posters contain no advertising and are suitable for tacking on field shacks, shop wall and bulletin boards, or framing for more permanent display. Featuring cartoon characters in typical job situations, the series sells proper tractor maintenance in a humorous, enjoyable manner and is keyed to seasonal problems. You can order as many copies as you need of the cartoon shown here, by sending your name, title, address and company name to J. I. Case Co.

Electric Wheeled Trucks For Mesabi Range (3)

UNIT RIG & EQUIPMENT CO., has announced the development and manufacture of a new 55-ton payload diesel electric truck. Officials at Unit Rig say that the truck has been designed to cut haulage costs 10 to 30%. The off-highway vehicle will incorporate the General Electric motorized wheel drive. Electric power for the wheels is supplied from a generator driven by a Cummins VT-12 engine. Each wheel has its own integral electric motor and simple gear drive arrangement. The entire motor is mounted within the rim, which in turn is bolted to the side of the vehicle. Photo will appear in January E&MJ.

Patented "Wagon Train on Rubber" (4)

LATEST entry in the field of dump truck haulage is Differential Co.'s side dump Train on Rubber, made up of a powered wagon with one, two, or more trailer wagons. These patented trains are built in two sizes: one for highway use with 15-ton capacity bodies, and a larger off-highway train with bodies carrying 25 tons each. The on-highway truck and trailers in the photographs have identical bodies 8 ft wide with 10-cu yd capacity, and will dump to either side. A solenoid valve on each body is controlled from a switch in the cab, so that the driver can dump the individual loads without leaving the cab. The larger off-highway Differential trains are powered by diesel engines 300 or 385 hp, and feature much higher ratios of payload to tare weight than conventional off-highway mining and earthmoving trucks.

Cutter-Tooth Auger Drill (6)

DESIGNED by Trainer Associates, Inc., the PoleBore auger is versatile in difficult ground conditions—comes with a two-way chuck to allow close, tight fit on more than one standard-size driving bar to eliminate the need for special adapters. The PolerBore digs quickly and efficiently, even in holes that usually mean trouble—through frost or frozen ground, rock, shale, hardpan, coral and sandstone. Based on a new cutting-tooth setting principle, Trainer's new auger digs and spins off in one smooth-functioning operation because its strategically placed teeth give fast, graduated cutting action for drilling, bulldozing or breaking up, according to the company.

Timken Roller Bearing Co. has purchased all the assets of British Timken Ltd. which will continue to operate under British personnel as a division of the parent company.

Penetrating Aerial Survey (7)

COMPLETION of the first successful tests of a new electromagnetic surveying system, known as AFMAG, has been reported by Fairchild Aerial Surveys, Inc. The new system is said to have two major advantages over conventional magnetometers. AFMAG is a Canadian developed, airborne geophysical prospecting system designed to bring two outstanding new characteristics to electromagnetic surveying, which is used primarily in the location of ores of copper and lead. First, a five to six times greater depth of penetration of the system is reported over conventional type electromagnetic survey systems. Second, because natural electromagnetic fields of the earth's atmosphere are used as a source of energy, no transmitter is required. This enable AFMAG surveys to be made from conventional aircraft and at speeds and elevations previously impractical with EM methods.

The tests were conducted, in cooperation with McPhar Geophysics, Ltd., over six separate mining districts in the western U.S. Tests results are reported as very satisfactory by Fairchild geophysicists.

Powerful Car Puller (8)

THE NO. 14H car puller developed by Stephens-Adamson brings the power of a locomotive to one man car spotting jobs while affording greater safety to operating personnel, according to the company. With the No. 14H wire rope car puller, there are no ropes to snub. The wire rope dead ends directly into the drum. A heavy duty clutch operated by a hand wheel permits drum to be released and turn freely in paying out rope. The clutch is easily engaged to start and pull a rated load.

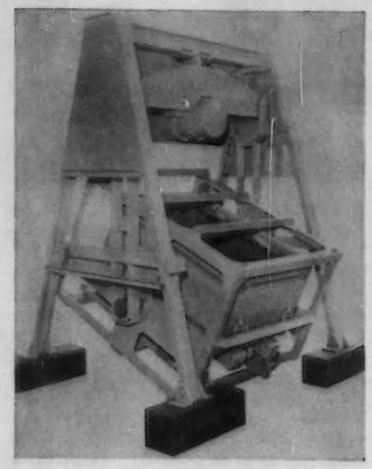
Dustless Rock Drill (9)

A NEWLY DEVELOPED dust collecting system for use with hand held sinker drills is now being offered by Le Roi Div., Westinghouse Air Brake Co. It can be used with any brand of rock drills, according to the manufacturer. Operation of the dust collecting system is simple. Dust and cuttings are trapped by a collar that fits around the drill steel and are inhaled through a connecting hose to a Le Roi DK280 dust collecting tank.

Mine Car Shake-Out (10)

GREAT SAVINGS in cost, improved efficiently and increased output are being achieved in British mines by the use of a newly designed Mine Tub Shake-Out which has been developed and manufactured by Sinex Engineering Co. Ltd. Equipment is marketed by Holman Brothers Ltd., who hold the exclusive selling rights.

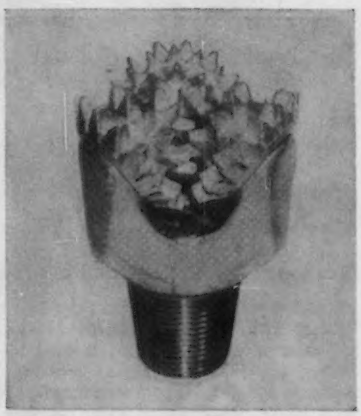
In many collieres, quarries and mines the ineffective and incomplete emptying of mine cars and pit tubs results in a gradual build-up of residual material. This accumulation of damp dust sets in



a very short time into a concrete-like substance which may account for anything up to 20% of the volume of the mine car or tub. Apart from this serious loss in capacity of the transport system, incentive payments are often based on full container output and the decreased efficiency, which is caused by residual deposits, results in serious financial loss. Attempts to break-up and remove this accumulation are often made by manual scraping and thumping and by the use of pneumatic and electric chipping tools. These methods are time consuming and are only partially effective and in many cases cause damage to the mine cars.

The Sinex mine tub shake-out comprises essentially a robust support frame in which is pivoted a tippler cage. The tippler cage, which accommodates mine tubs of up to 1-ton capacity, is suspended by two hanging trunnions from a beam structure which carries a Sinex 3,000-rpm rotary electric high amplitude vibrator.

Christensen Diamond Products Co. is going into the hard metal bit field and will produce, through the Carbide Bit Div. threaded and push-on carbide bits, and integral steel chisel carbide types.



Bit Maintains Gage (11)

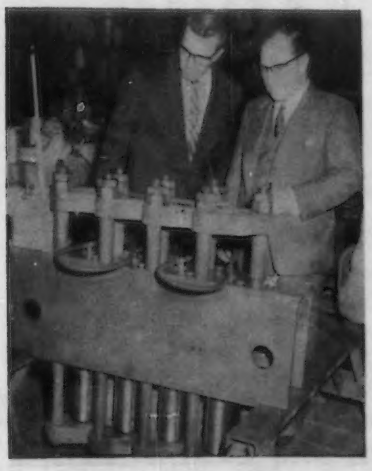
VAREL MFG. CO. has developed a new formation type rock bit to meet the immediate needs of blast hole drilling

where fast penetration rates are necessary but where excessive gage wear has been a problem. The new bit formation type is the Varel VH3T developed by Varel engineers to provide operators with increased footage and lower cost operation in abrasive formations of medium hard limestone or sandstone where gage wear previously resulted in shorter bit life. The Varel VH3T type bit maintains accurate gage and still provides fast penetration rates necessary for low blast hole drilling costs. The new bit reflects Varel's advanced engineering development of balanced design in which each cone's tooth-cutter arrangement is balanced in relation to the other cones. To assure long bearing life and even bearing wear on all three cones while providing optimum bottom hole cutting pattern for faster drilling, according to the company.

Explosion-Proof Locomotive (12)

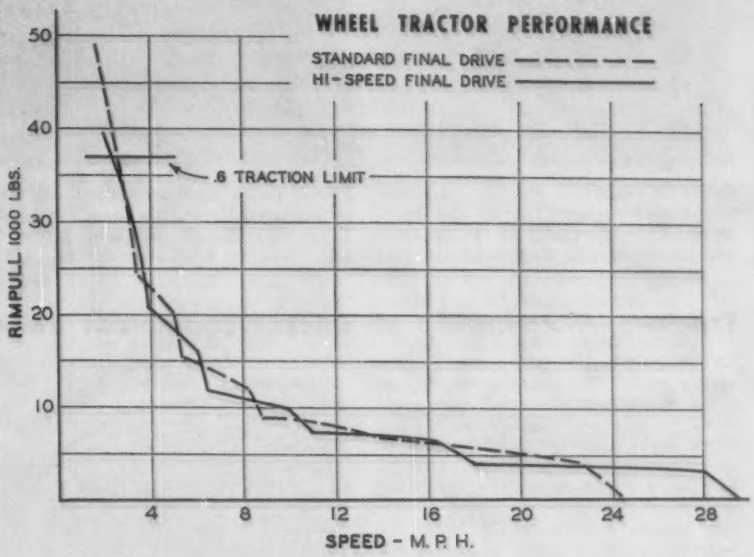
A LINE of explosion-proof diesel hydraulic locomotives will be offered on the U.S. market by Henschel-Werke GmbH and by its U.S. representative, Norca Machinery Corp. The locomotives are designed for use inside oil refineries, plants handling explosive liquids and underground mines. Features designed to insure safety against explosion include the regulation of the exhaust gas temperature by means of water injection into the exhaust pipe and a thermostatically controlled shut-down valve that operates when exhaust temperature exceeds 320° F. The engines also have a valve that shuts down when the engine speed is reduced below a preset minimum.

Joy Mfg. Co., which has acquired rights to make and sell the Carpco High-Tension electrostatic separator and the Hazemag impact crusher, has just recently purchased Western Precipitator Corp., maker of dust collection and pollution abatement equipment.



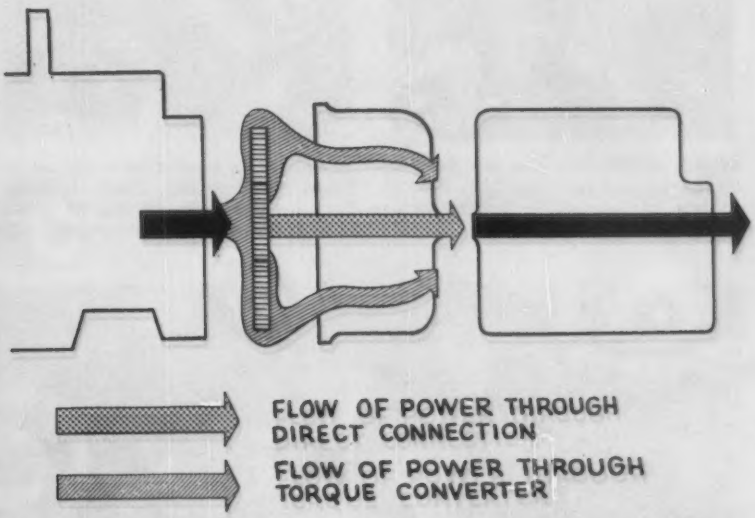
Cage Rope Equalizer (13)

LAKE SHORE INC. has recently introduced a new hydraulic equalizer assembly for mine skips and cages for use with multiple ropes. The unit automatically equalizes the multiple rope suspension and is used with Koepe-type hoists. According to Lake Shore's mining machinery sales engineer, John Jamar, the unit will compensate for a large amount of variation in rope lengths. Shown inspecting it are John Jamar and E. R. Tickton (right).



High Speed Final Drives For Bowl Scrapers (16)

IF THE HAULAGE roads are in good condition, if the total grade-plus-rolling resistance does not generally exceed 120 lb/ton, and if haulage distances are in excess of 2,000 ft, high speed final drives effectively can cut over-all cycle time and operating costs for two-wheel tractor-scrapers. The greater speeds (up to 23% faster) at reduced rimpull capacity (about 81% of standard drive machines) can mean a considerable cost advantage in favor of the high speed drive over the standard unit, according to Caterpillar Tractor Co.



Transmission Combines Direct and Torque Converter Drive (17)

A UNIQUE use of planetary gear versatility is now available on Caterpillar Tractor Co.'s D8 and D9 tractors in the form of a combination power transmission train that sends one-third of the power through the transmission imput shaft and the remaining two-thirds through a torque converter. Caterpillar says that the method provides a greater over-all efficiency than a standard torque converter and yet retains the solid feel of a direct drive arrangement. Power in the D8 and D9 have been boosted to 235 and 335 hp respectively. A single range-selection lever on the operator's deck takes the place of clutch lever, gear selector and the forward-reverse lever, providing more effortless shifting.

COMPLETELY new in design, the Model C-6 Euclid employs 211 hp and Torqmatic drive consisting of a converter and semi-automatic transmission. **(21)**

FEATURING 6-cylinder diesel engines, International Harvester's Drott TD-9 and TD-6 Skid Shovels are now provided with 500-hour lubrication rollers. **(25)**

STANDARD bucket size on Model W-10 Case Terraload'r 4-wheel drive unit is 2 cu yd, but a lightweight 2⅞-cut yd bucket is optional equipment. **(26)**

Tractors—A Round-Up on Recent Equipment Releases

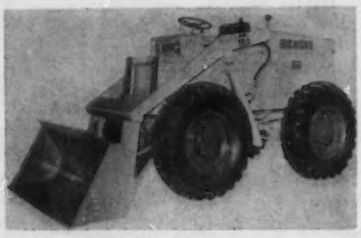
IN THE PAST few months a rush of new tractor models have come on the market —big ones, bigger ones, small ones, completely redesigned models and lines. Clark has a small Michigan—Euclid redesigned the C-6—Case's Model W-10 will take a 2⅞-cu yd bucket—and so on. Shown on this page are some of the new models introduced. For more information on these items—as well as the items discussed elsewhere in New Products Digest—circle the proper number on the readers' reply card, give your name and address and mail (with proper postage) to E&MJ.

LATEST addition to the Trojan line of Yale & Towne Mfg. Co. is a Model 164 with 5-ton capacity. Model 134 (not shown) is similar, but smaller. **(23)**

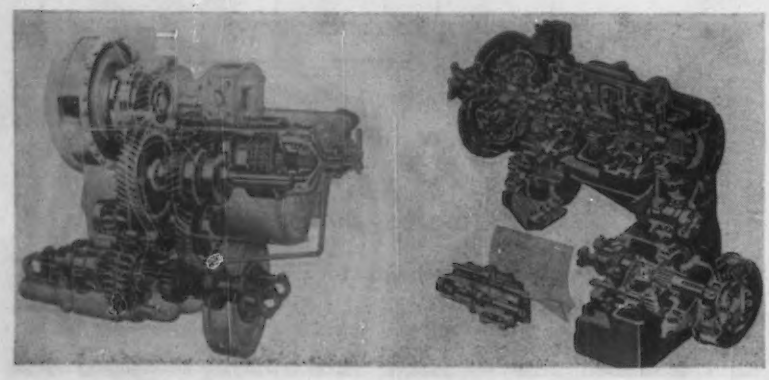
DIESEL power is employed in Yale & Towne Mfg. Co.'s Trojan Model 304 which features a 3-cu yd bucket. **(24)**

MOST POWERFUL unit ever produced by International Harvester Co.—the TD-25 is available with or without torque conversion. Net horsepower is 230. **(22)**

ALREADY in production to replace the Model HU Payloader, Frank G. Hough Co.'s 4-wheel drive rubber-tired Model H-50 has diesel or gasoline engine. **(28)**



SMALL Michigan—1-cu yd bucket—has all the features of its five larger brothers according to Clark Equipment Co. Model 55-A has 66.5hp. **(29)**



Two Transmissions Available for Tractoloaders (18)

TWO TYPES of transmission have been developed by Allis-Chalmers Mfg. Co. for the wheeled Model TL-14 Tractoloader. At left above is the four speed Tractomatic power-reversing design and at right is the Allison full power shift method. Tractomatic transmission has steering column lever for controlling direction of motion and a floor pedal for floor-board lever for speed selection. In the Allison version, one lever controls speed and direction.

An agreement has been signed among Koppers Co., Inc., Strategic Materials Corp. and Elektrokemisk A/S whereby Koppers will design and build integrated Udy-Process direct reduction steel plants and Elektrokemisk will, under certain circumstances, design and supply the electric furnaces.

For Your Files

This selected manufacturer's literature is free unless otherwise specified. If item is for sale, send request and money direct to manufacturer.

SEMI-AUTOMATIC hoisting practices for small mines is the subject of a pamphlet (HP-5911) released by Vulcan Iron Works Co. (Denver). A low-cost hoisting system using ac power is described. **(60)**

SAFETY HATS from Flood Safety Products Co. are illustrated in a four-page bulletin (18). **(61)**

REAR DUMP variable wheel base trailer from Easton Car & Construction Co.—the 35-ton Easton TS-2635—is featured in a bulletin (2-A8). **(62)**

CRAWLER TRACTOR—the Euclid Model C-6—is presented in a 24-page bulletin. (607). **(63)**

ELECTRICAL equipment available from Ohio Brass Co. is presented in a 40-page catalog supplement (No. 2). **(64)**

UNIT-TYPE compressors from Le Roi Div., Westinghouse Air Brake Co. are discussed in a 12-page bulletin (SG-2). Pressures available—80 to 250 psi. **(65)**

HANDLING of ores, sand and gravel and other bulk materials is the subject of a 16-page brochure on the Sauerman Bros. Inc., DragScraper and Cableway machines. **(66)**

SIX-CYLINDER interchangeable diesel and carbureted engines—International Harvester's UD-236 and UC-221 rated at 75hp; and the UD-282 and the UC-263 rated at 95hp—are discussed in a 12-page bulletin (CR-608-I). **(67)**

THE NEWEST Dynamotive electric-drive fork truck is illustrated in four-page bulletins (6008-AR and 6009-AR) from Automatic Transportation Co. **(68)**

TRUCK CRANES in the American Hoist & Derrick Co. 60-ton 700 Series are illustrated in a 16-page bulletin (TG-2). **(69)**

FORTY-FIVE deg troughing conveyor belting from Raybestos-Manhattan, Inc. is described in a 12-page brochure. **(70)**

SOLENOID valves stock list from Automatic Switch Co. lists all the models available along with a selection guide and a price list. (506). 14pp. **(71)**

PRECISION measuring tools and instruments catalog and guide prepared by Sherr-Tumico lists and describes all the instruments available. (25). 96pp. **(72)**

AIR-HYDRAULIC boosters bulletin published by Miller Fluid Power Div., Flick-Reedy Corp. discusses applications, selection, detailed circuits and operating features of the Miller line. (B-200P). 24pp. **(73)**

DATA on the new Size 8E All-Motor Motoreducer (98½% efficiency per gear mesh) is available from Falk Corp. (3100.01) Size 8E is designed for low speed (520 to 1 rpm) 1 to 75 horsepower applications. **(74)**

FLAME-PLATING process for applying coatings of tungsten carbide and aluminum oxide to various base metals is described in Linde Co.'s bulletin (F-118a-A). 4pp. **(75)**

SUBMERSIBLE PUMPS in the Flygt line are illustrated and discussed in literature available from Stenberg Mfg. Co. Many sizes are available. **(76)**

EQUIPMENT—pumps, motors, transmissions, cylinders and valves—in the Oilgear Co. Fluid Power line are tabulated in 16-page bulletin (10051-H). **(77)**

MINERAL FLOTATION with Armour Industrial Chemical Co. cationic chemicals is the title of a 16-page illustrated bulletin. **(78)**

SCIENTIFIC and test instruments available from Minneapolis-Honeywell Regulator Co. are thoroughly documented in a 48-page condensed catalog (G-10)—recorders, amplifiers, data handling systems, potentiometers, millivoltmeters and null indicators, etc. **(79)**

ULTRA-HIGH pressure blast furnace operation and performance is the subject of a 30-page illustrated brochure from Koppers Co., Inc. Article shows how 40 psi top pressure can double pig iron production. **(80)**

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BUTTERFLY VALVES—the Henry Pratt Co. Monoflange Mark II Rubber Seat line—is documented in a catalog (10GT) which gives complete specifications, water and gas flow data, and prices. **(81)**

DATA PROCESSING equipment, including analog and digital computing systems, is presented in a publication from Leeds & Northrup Co. (N-07 (1)). **(82)**

BELT WEIGHER for weighing and feeding dry materials is the subject of a two-page bulletin on the Omega Pneu-Weigh Model 36-20W system prepared by B-I-F Industries, Inc. Capacity ranges from 0 to 3,000 lb/min and the unit is easily adapted for recording, pacing and controlling. **(83)**

COOLING TOWERS for either indoor or outdoor use in the Kennard/Nelson line by American Air Filter Co. are discussed in a 4-page bulletin (KT-104). Unit is of the induced draft centrifugal fan design. **(84)**

1958 FLOTATION REVIEW by Nathaniel Arbiter is available from American Cyanamid Co. in the form of a 15-page booklet. **(85)**

ANALYTICAL INSTRUMENTS in the Jarrell-Ash Co. line are introduced in an eight-page bulletin—spectrometers, microphotometers, x-ray diffraction. **(86)**

APPLICATION of fatty acids to flotation is the title of a six-page article by Robert E. Baarson and John R. Parks. Armour Industrial Chemical Co. **(87)**

DESIGN considerations and operating experiences in clarification of high color low turbidity waters is the title of a reprinted article from the 20th annual water conference of the Engineers' Society of Western Pennsylvania. Available from Graver Water Conditioning Co. (T-176). 7pp. **(88)**

CASE HISTORY report on the application of reinforced polyester in filter presses is contained in a four-page bulletin on Thermaflow 100 from Atlas Powder Co. **(89)**

ALUMINUM strip conductor specifications and data sheets are available from Reynolds Metals Co. Strip conductor is used primarily for winding electromagnetic coils in transformers, lift magnets and solenoids. **(90)**

POCKET GUIDE to steel analyses prepared by Jones & Laughlin Steel Corp. lists the composition of 40 stainless steels, 184 alloy steels and 105 carbon steels most used in industry. 20pp. **(91)**

BRASS and steel tube fittings, tools, hose and assemblies available from Weatherhead Co. are presented in a 16-page catalog (C-301). **(92)**

AN ARTICLE prepared by A. M. Byers Co. discusses the working properties, availability and suitability of Mn wrought iron (1% Mn) for low temperature service. 8pp. (15-D). **(93)**

A QUICK guide to the nickel-containing casting alloys is the title of a 27-page pocket-size booklet prepared by International Nickel Co. **(94)**

LIGHTWEIGHT structurals — ideas that promote fast, economical building construction—are highlighted in Jones & Laughlin Steel Corp.'s 16-page booklet (AD 263). **(95)**

SODIUM zeolite process of water softening is the subject of a booklet prepared by Cochrane Corp. describing the process and giving information on selection and sizing of equipment. **(96)**

COMPLEX problem of floating lead-barite-fluorspar ores is discussed in a flowsheet study available from Denver Equipment Co. Bulletin No. M7-F67 illustrates the entire process from the coarse ore bins to the dryer and discusses the several new reagents employed. **(97)**

GAMMA radiation gages — Models LRV and LR from Ohmart Corp. — for measurement of specific gravity, per cent solids or liquid interface location are presented. **(98)**

ROTATING disk, gravity-flow, countercurrent contractor-extractor — the Turbo Mixer RDC — and its application to the solvent extraction process are the purposes of a bulletin (T-1159) from Turbo-Mixer Div., General American Transportation Corp. 8pp. **(99)**

FILTER drain valves, backwash and rewash valves are pictured in an eight-page bulletin (W-18) published by Golden-Anderson Valve Specialty Co. **(100)**

Literature For Sale

FILLER metal comparison charts contained in the American Welding Society's 48-page booklet represent the most complete set of welding rod and electrode data available. Write, send money to the Society, Dept. T, 33 West 39th St., New York 18, N.Y. Price $2.50.

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For an old-fashioned winter — this new-fashioned Primacord

You can get tight knots and hook-ups even with stiff fingers when the weather's *cold!* Ensign-Bickford's new LO-TEMP Primacord is very flexible, easy to handle, and knots securely at *all* temperatures — even down to *minus* 40°F.!

LO-TEMP can be used for in-hole priming wherever conditions do *not* call for our more rugged types of Primacord. Use it as the trunkline for *all* hook-ups. Detonate with fuse and cap or electric blasting cap, side-taped about eight inches in from the end of the trunkline, and with the business end of the cap pointing in the direction of the blast.

Like all types of Primacord, LO-TEMP is very insensitive to initiation by shock, friction, sparks or electricity. When initiated with a blasting cap, it explodes at a velocity of 21,000 feet per second and has the initiating energy of a blasting cap along its entire length.

Square knot for trunklines
Loop-lock half hitch on Plastic Wirebound
Half hitch in trunkline around Plastic Reinforced downline

For connecting trunklines and downlines

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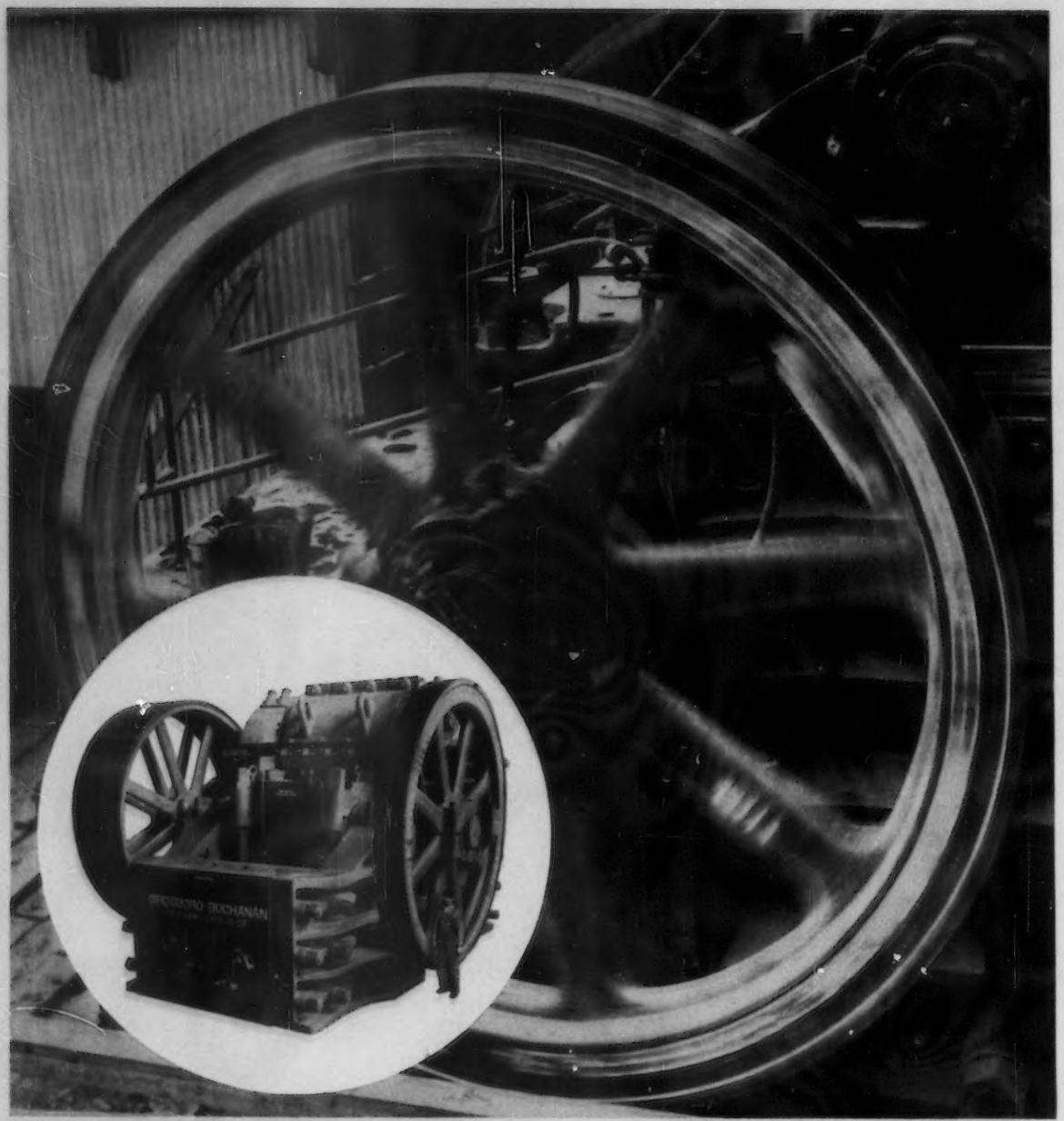
Simsbury, Connecticut – Since 1836



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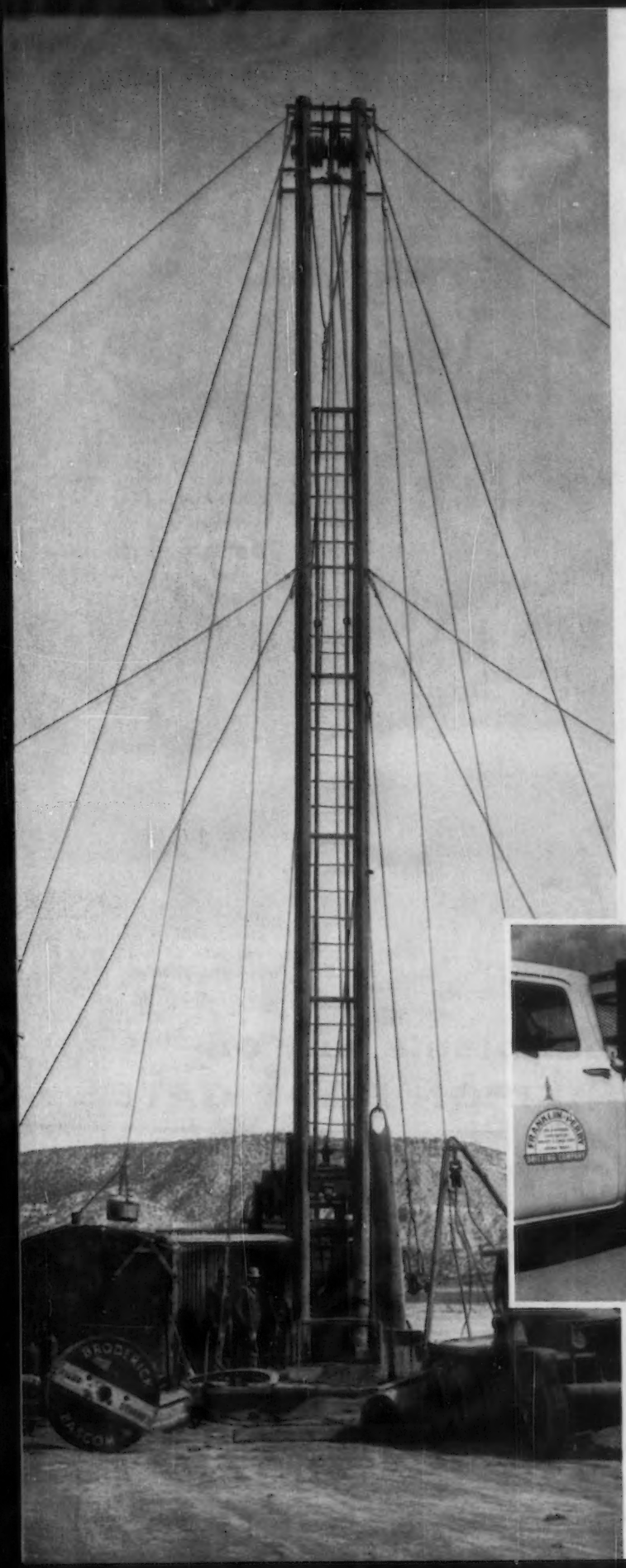


Yellow Strand BRODRIL drills

URANIUM ESCAPE SHAFTS

To punch 4′ holes ⅛-mile down into the largest uranium field in the world, Franklin & Perry Drilling Company, Ozona, Texas, put Yellow Strand BRODRIL to test. BRODRIL carries a 24″ spud to churn through the initial hole. Then it handles an 8,000 lb., 48″ reamer to finish drilling the giant-size shaft that is used for escape and vent.

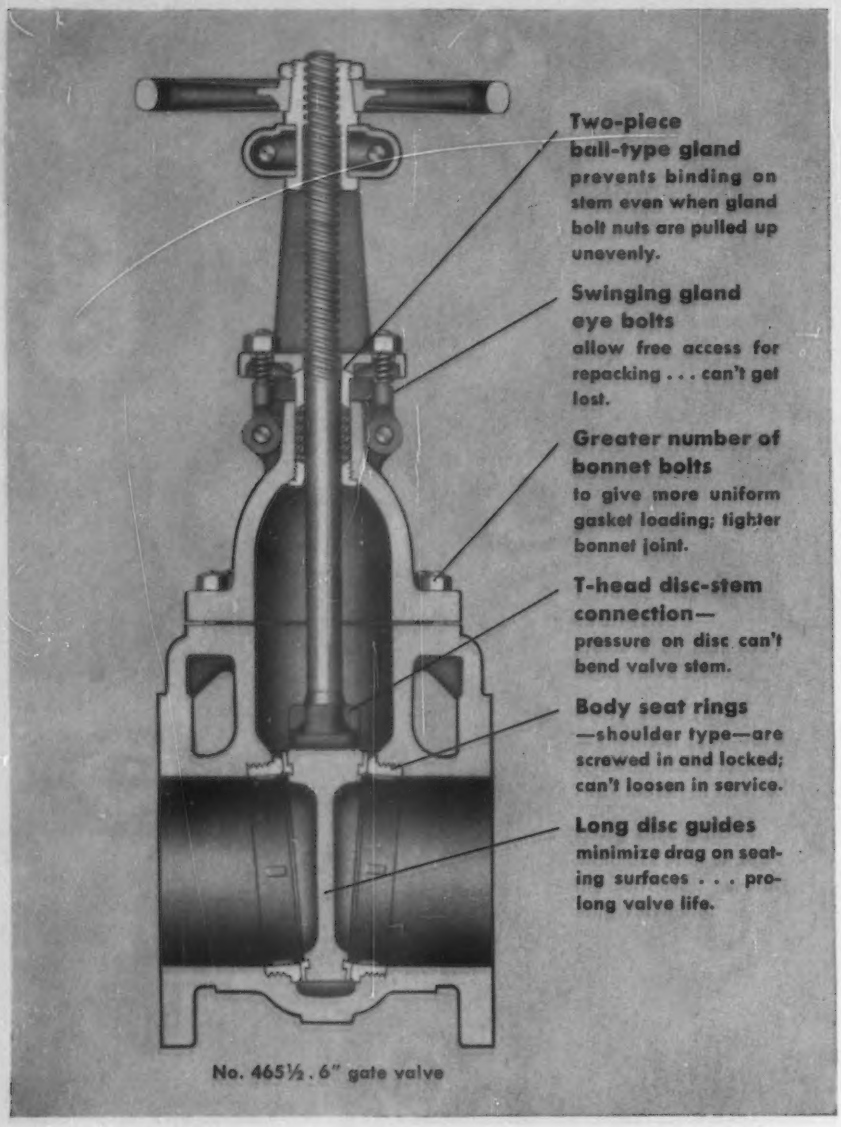
1″ 6 x 21 left lay BRODRIL fiber core cable tool line is used on the spudder, and ⅝″ 6 x 7 Yellow Strand fiber core is used for the sand line.

"Our BRODRIL lines wear longer under the severe pressure, shock, and jarring pull-down than any other rope we've used," says E. D. Strickland, job superintendent.

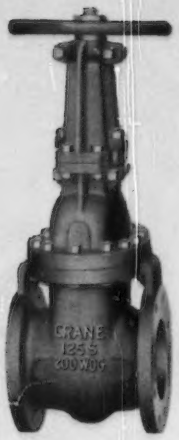
Tell your B & B representative to show you how the high abrasion resistance, resiliency, specially fortified fiber core and long-lasting lubrication of Yellow Strand BRODRIL can help hit the pay zone faster! Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.

Yellow Strand®

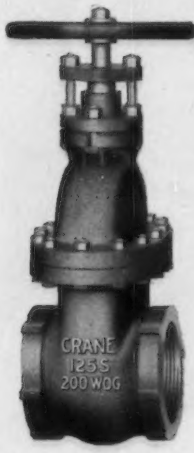
WIRE ROPE SLINGS CLIPS


Two-piece ball-type gland
prevents binding on stem even when gland bolt nuts are pulled up unevenly.
Swinging gland eye bolts
allow free access for repacking . . . can't get lost.
Greater number of bonnet bolts
to give more uniform gasket loading; tighter bonnet joint.
T-head disc-stem connection—
pressure on disc can't bend valve stem.
Body seat rings
—shoulder type—are screwed in and locked; can't loosen in service.
Long disc guides
minimize drag on seating surfaces . . . prolong valve life.

No. 465½. 6" gate valve



No. 465½. 125-Pound, OS&Y, bronze trimmed. Flanged ends. 2" to 48". Also in all-iron.



No. 460. 125-Pound, non-rising stem. Bronze trimmed; screwed ends. 2" to 8". Also in all-iron (to 4" only).

The valves most plants rely on—
CRANE 125-POUND IRON BODY GATES

On general utility services . . . water mains and distribution lines . . . low-pressure steam and hot water . . . air and gas . . . more plants rely on Crane No. 465½ iron body bronze trimmed gates than on any other valve in this class. The cross section above reveals some of the advantages of Crane improved iron valve design . . . how they assure dependable operation through long life and provide for convenient servicing.

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FAST, LOW-COST INSTALLATION. Simple construction facilitates field assembly, reducing time and costs of erection.

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No other conveyor offers such rugged design and economy of operation in bulk materials handling. Call your nearby Link-Belt office for complete information. *Or write for Catalog 2779,* a new "Idea Book" for cutting costs with Link-Belt Pre-Bilt sectional belt conveyors.

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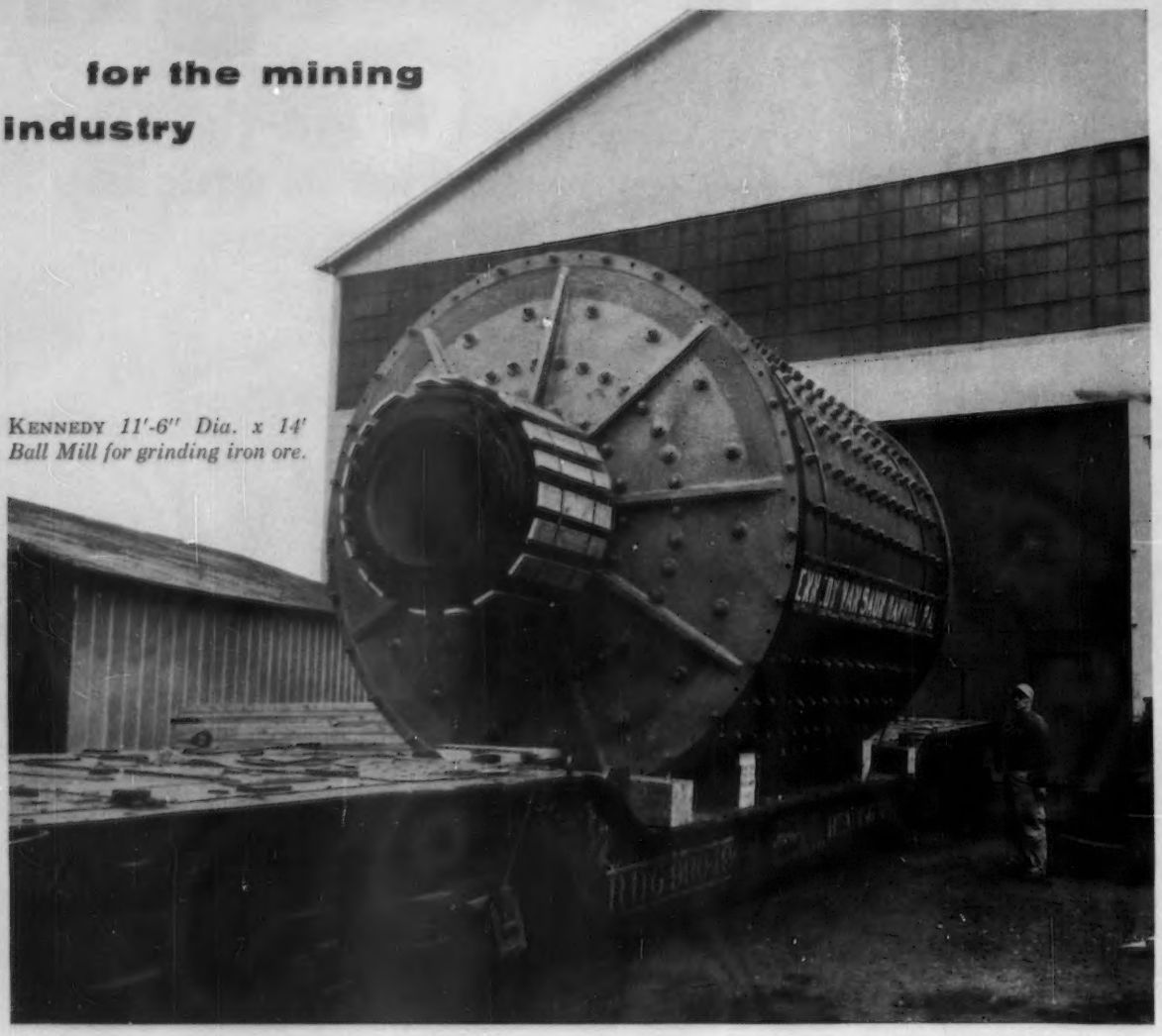
for the mining industry



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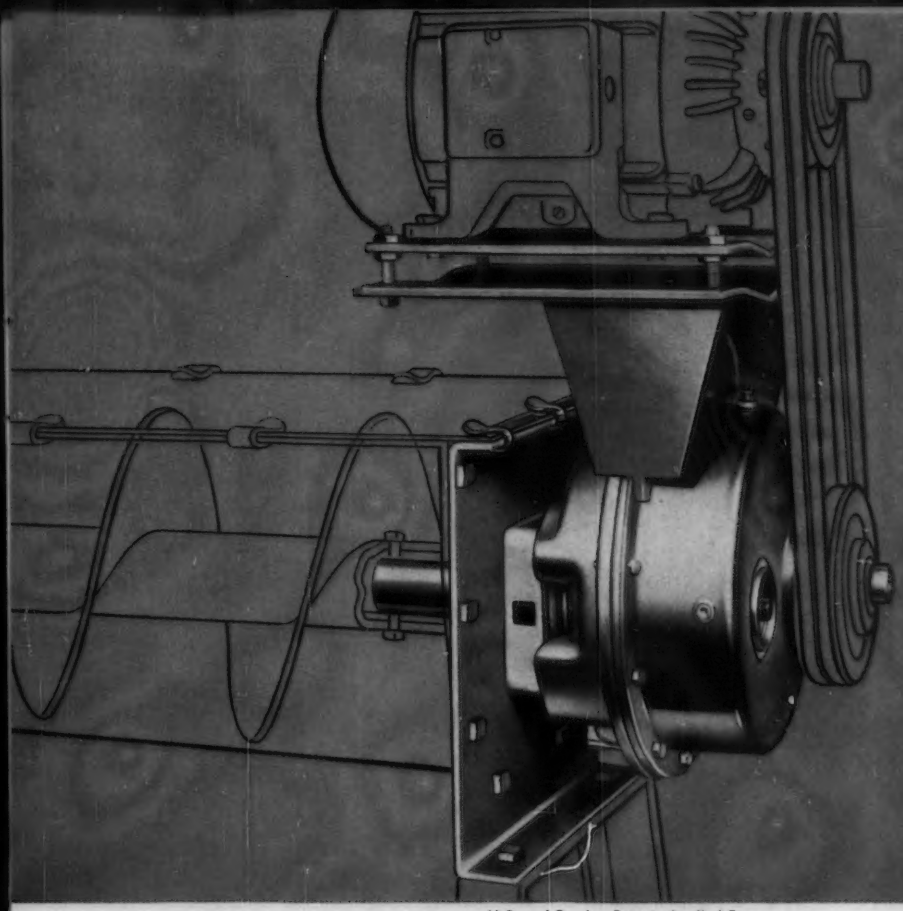

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—the drive our customers asked for

Our customers helped us design this new unit. We sent our men into the field to find out what our customers needed in a screw conveyor drive—then our engineers designed a new drive that offers the maximum of service, versatility, operating economy and long life. Here are some of its outstanding features:

A COMPLETE DRIVE: Saves engineering and assembly time. Six sizes to cover entire range—each with these ratios: — 4:1, 9:1, 14:1 and 24:1. Bolts to any standard trough end—eliminates trough end bearing. Eliminates drive shaft wobble. Efficient FALK single helical gears.

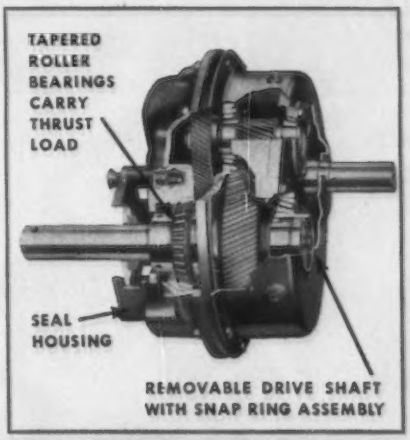
SEAL HOUSINGS: Choice of seals (neoprene or leather lip, felt or waste) to accommodate material conveyed. Space between trough seal and unit seal prevents conveyed material from reaching unit seal.

REMOVABLE DRIVE SHAFT: Snap ring assembly permits easy removal. Five sizes, from 1½″ to 3⅞″.

TROUGH END: Can be fastened to any standard trough. Eight sizes, from 6″ to 20″.

ALL-STEEL MOTOR MOUNT: Saves costly engineering and installation time and costs; no motor plates to design or fabricate. Motor can be mounted in virtually any position. Pre-drilled to accommodate NEMA standard motors ½ to 30 HP.

AN IMPORTANT ECONOMY: Buy only what you need—the basic reducer alone, or with trough end and/or motor mount. For detailed information, contact your Falk Representative or Distributor—or ***write direct for Bulletin 7106.***



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NEW CAT DW20 4-wheel, 345 HP Series G Tractor with 24 cu. yd. No. 482 Scraper

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BIG NEW CAT WHEEL RIGS CUT PRODUCTION COSTS

You name the job...these new Cat Wheel Tractors and matching LOWBOWL Scrapers can do it better with faster cycles and greater production, at lower cost. For example:

DW20-DW21 Series G Tractors and matching LOWBOWL Scrapers Now these big wheel tractors develop 345 HP—an increase of 8% over former units. Both tractors have 12% more rimpull than before—the DW20 develops 39,565 lb. (maximum) rimpull, and the DW21 has 49,100 lb. (maximum) rimpull. As a result, the new rigs travel faster (up to 20%) under similar haul road conditions. To accommodate this greater power and capacity, improvements have also been made in transmission and final drive.

Matching the increased horsepower and productivity of the Series G Wheel Tractors are the new No. 456 and No. 470 Series B LOWBOWL Scrapers. Rating is increased 8% to 19.5 cu. yd. struck and 27 cu. yd. heaped. (Rating on the No. 482 is 24 cu. yd. struck and 34 cu. yd. heaped.) Bowl, draft frame and apron are strengthened for greater resistance to tough materials and rugged loading—withstand higher loading stresses.

No. 619 Series B Wheel Tractor and No. 442 Series B LOWBOWL Scraper Here is the latest addition to the Caterpillar line of high-speed earthmoving equipment. This brand-new earthmover is a 14 cu. yd. struck (18 cu. yd. heaped) unit featuring ground-hugging roadability, "years ahead" service-accessibility, and high productivity. The No. 619 has a turbocharged 225 HP engine (and high torque rise), planetary final drives, unit construction, tubeless tires, a swing-away dash, 2-jack steering, and a dry-type air cleaner, providing the design and performance features that insure superior workability on a broad range of applications. All this in the new No. 619-No. 442 unit—plus proved economy over any earthmover of comparable size.

DW15 Series F Wheel Tractor and No. 428 LOWBOWL Scraper Greater strength and productivity in the well-known four-wheel DW15-No. 428. Bevel gear and pinion, differential and front wheel spindles offer increased service life. Machine delivers 200 HP. The big LOWBOWL Scraper handles 13 cu. yd. struck, 18 cu. yd. heaped. Can be unhitched to haul other units.

Plan your work around these new Cat Wheel Rigs for top production at lowest cost: The DW20-DW21 Series G, the new No. 619 and the DW15 Series F. The complete facts are at your Caterpillar Dealer. Call him today for a demonstration.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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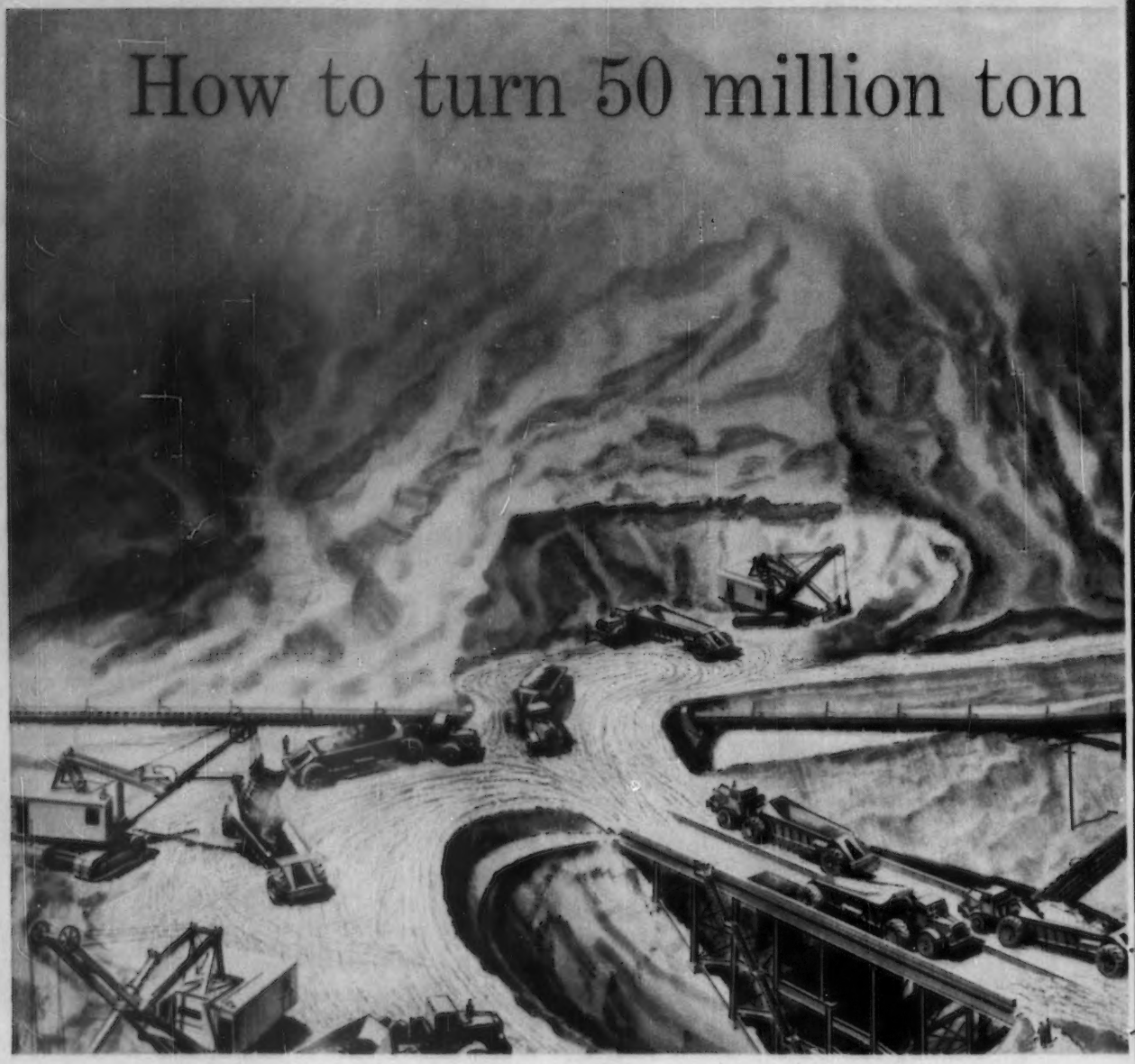
How to turn 50 million ton



HEWITT-ROBINS CONVEYOR BELTING OF HIGH-TENACITY ENKA RAYON

Hewitt-Robins conveyor belting of high-tenacity Enka rayon scores an engineering triumph on the Great Salt Lake project.

In 1956, Morrison-Knudsen began construction on a 13 mile embankment across the Great Salt Lake for the Southern Pacific Railroad. Hewitt-Robins was awarded the bulk materials handling system to screen and move 50 million tons of gravel two miles from hillside to lakeside.

A giant conveyor belt system was set up at Great Salt Lake. This system used more than 23,000 feet of belting, designed to move 90,000 tons of gravel a day and travel at twice the speed of conventional belts.

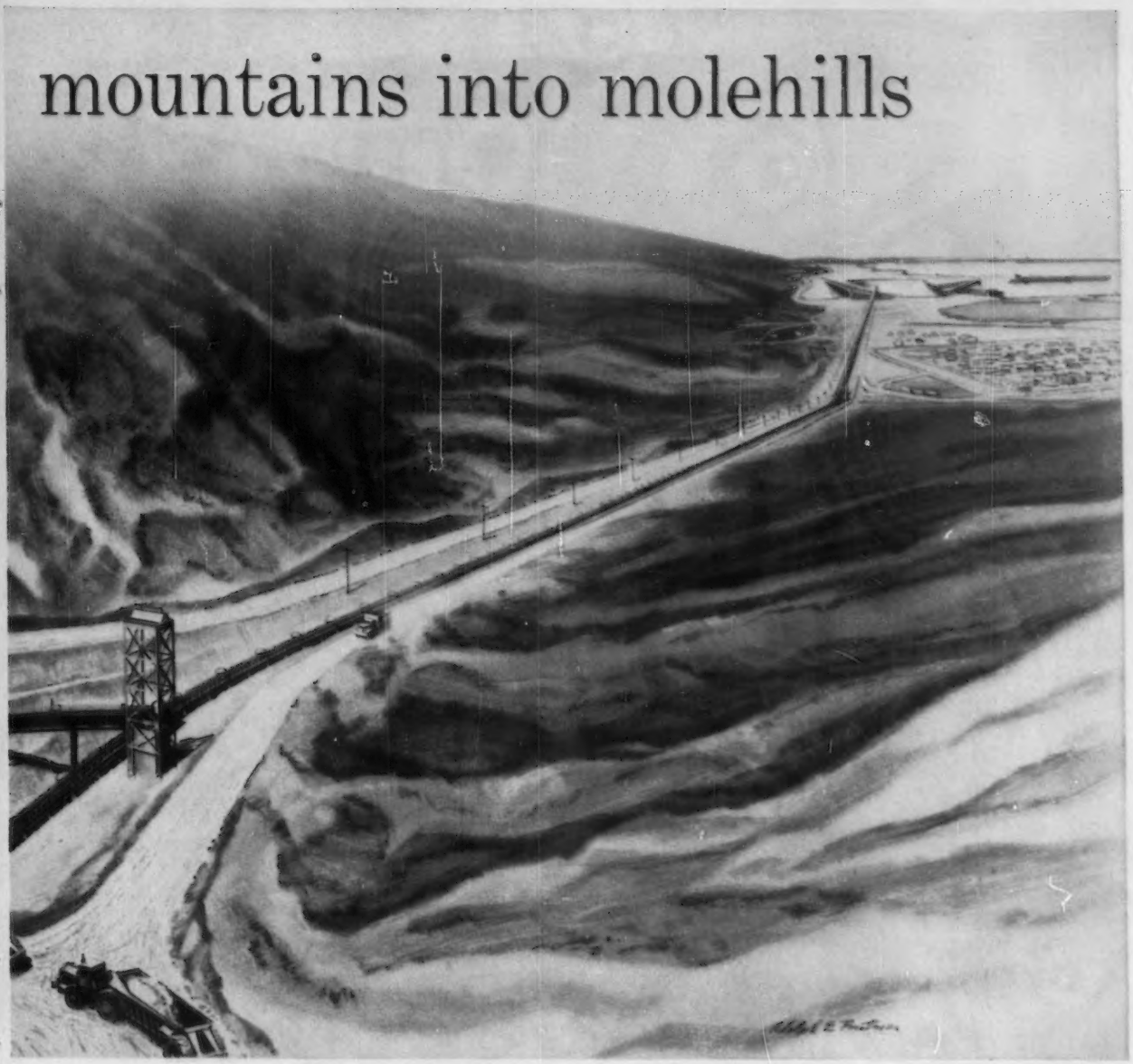
To operate at this twenty-two hours per day schedule, Hewitt-Robins chose belting made with high-tenacity Enka rayon. The belting withstood severe heat and humidity without loss of strength or flexibility. Maintenance costs were kept to a minimum.

After two years of steady operation, this conveyor belting completed its assignment and components of the system were dismantled and resold.

For the Great Salt Lake project and hundreds of others each year, Hewitt-Robins specifies high-tenacity Enka rayon. They know that Enka rayon makes stronger, longer-wearing, more economical conveyor belts.

American Enka Corporation • 530 Fifth Avenue, New York 36, N. Y. Leading producer of yarns

mountains into molehills



SCORES AN ENGINEERING TRIUMPH ON THE SALT LAKE CITY PROJECT

Pound for pound, Enka Rayon is your best value in industrial yarn

Specify Enka high-tenacity rayon yarns for industrial rubber products, chafer fabrics, heavy-duty sewing thread and many other vital end-use applications.

Greater strength • More elasticity • Increased heat and humidity resistance • Higher safety factor • More economy • Superior flexibility • Better shock absorbency • Longer service • Less maintenance.

Write for Hewitt-Robins brochure on C/R conveyor belting of high-tenacity rayon and cotton. It gives technical data on strength and other characteristics of belting made with cotton-rayon fabric. Write Hewitt-Robins, Stamford, Conn. Ask for bulletin 12-16A.

ENKA high-tenacity rayon for industry

and fibers for apparel, home and industry, and Tyrex® viscose tire yarn.

MSA's continuous MinePhone research and development assures

KW-DART 40T
450HP — 40 Ton Payload

with TIME and POWER to spare

When the KW-DARTS come roaring out of the pit, there's lots of power left over. Every KW-DART is job engineered — with combinations of components matched to do the job faster and easier. That's why KW-DARTS perform better . . . for lower maintenance costs . . . and for longer service life.

There are KW-DART sales engineers near you who can analyze your specific needs. Your phone call or letter will bring an immediate response.

KW-DART TRUCK CO.

Subsidiary of Pacific Car and Foundry Company

1301 North Manchester Trafficway
Kansas City 41, Missouri, U.S.A.

P.O. Box 321

152

MSA's continuous MinePhone research and development assures dependable underground communication in mines and areas previously thought inaccessible for this type of equipment.

Built-in → quality here

increases safety and dependability here

The motorman has clear, instant voice communication with the dispatcher or other motormen while trips are moving.

M-S-A MinePhone helps mine operators gain and maintain fast, high-capacity haulage schedules

Briefly, here's how the M-S-A® MinePhone helps keep haulage schedules abreast of production in today's mechanized mines.

The MinePhone coordinates trip traffic for safe, fast, productive haulage control. Trip control avoids excessive power loads for economical operation. Assures better distribution of cars for peak loading efficiency.

Further, a MinePhone system reduces frequency of motormen and trip riders getting on and off trips. This saves time. Minimizes chances of injury. Reduces wear and tear on haulage equipment caused by excessive stopping and starting.

Finally, the MinePhone speeds up operations of maintenance crews. Provides an efficient, time-saving underground call system. Keeps main line haulageways free of time-consuming traffic tie-ups.

Your MSA representative would be pleased to arrange a demonstration for you. Call him in for an evaluation of your communication needs. And write us for informative literature on the MinePhone.

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pennsylvania

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
Toronto, Calgary, Edmonton, Montreal, Sydney, Vancouver, Winnipeg

MSA® SAFETY EQUIPMENT HEADQUARTERS

Duval Sulphur & Potash Co., Carlsbad, N. Mex.

He's taking clay to the cleaners

A 400-pound problem—clay—rides piggyback into this tank on each 20 tons of sylvinite ore.

The clay clings tight to the crushed crystals of potash and rock salt. If the heavy clay ever got beyond the tank and into the flotation cells, where potash and rock salt are separated, it could raise havoc with plant production figures.

But it never does. Good fluid mixing, with a LIGHTNIN Mixer, washes the sticky clay from the crystals—24 hours a day, seven days a week. As a result, the flotation process can work at top efficiency all the time.

Balanced mixing A trio of 30-hp LIGHTNIN Mixers with big turbine impellers drive saturated brine and ore, at 60% solids, in constant vigorous flow throughout this 5,600-gallon tank and two others. Powerful mixing action combines *fluid flow* and *turbulence* in the right balance to wipe crystals clean, wet them thoroughly, and suspend them uniformly in the cell feed.

Clouds of corrosive chloride dust from the dry ore, and salt spray from the brine troughs, don't bother these rugged mixers. Their working parts have the most complete weatherproofing protection available in any speed reducer.

You get more out of your ore when you mix with LIGHTNIN Mixers. You can get them in sizes up to 500 hp, in hundreds of standard power-speed combinations, factory-aligned and ready to install.

Most important, LIGHTNIN Mixers give you guaranteed results—results you can *measure* in terms of faster throughput, better extraction percentages, closer quality control, more product from fewer reactors.

Ask us to show you how and why. Just call your LIGHTNIN Mixer representative. He's listed in Thomas' Register. Or write us direct.

WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 hp (B-102)
- ☐ Top entering; propeller types: ¼ to 3 hp (B-103)
- ☐ Side entering: 1 to 25 hp (B-104)
- ☐ Portable: ⅛ to 3 hp (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals (B-111)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 234-n Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

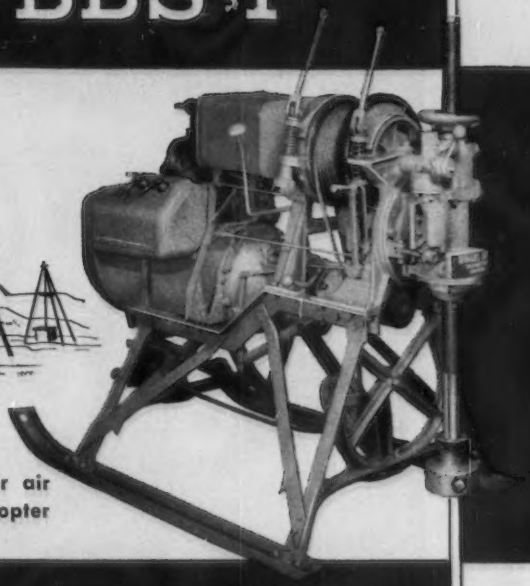
Lightnin® Mixers

MIXCO fluid mixing specialists

you're looking at the most USEFUL surface diamond drill you can buy the BBS-1

● **with 12 AH swivelhead**
("BW" rod size)

Here is BBS-1 fitted with twin cylinder oil hydraulic swivelhead, hydraulic self-centering chuck, folding mast and skid mount. This assembly combines exceptional feed control with high penetration speed. Handles "BW" rods to 800 ft., "AW" rods to 1100 ft., "EW" rods to 1500 ft.



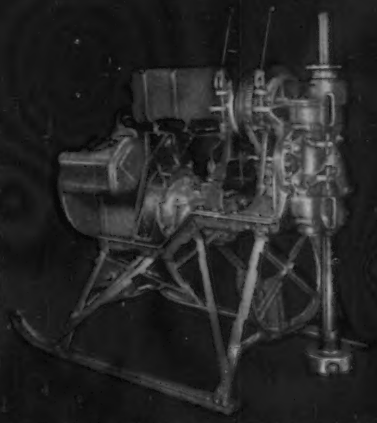
● **A FEATURE!**
Easily dismantled for air transportation—helicopter or airplane.

● **with 1-JEG swivelhead**
("EW" rod size)

This heavy duty gear feed swivelhead incorporates an instant shift mechanism to any of four feeds, regardless of speed or bit pressure. Handles "EW" rods to 1200 feet. This head is interchangeable with our JV model.

● **with 12 AG swivelhead**
("AW" rod size)

Equipped with this four feed gear swivelhead, BBS-1 handles "AW" rods to 900 ft., "EW" rods to 1200 ft. — gives heavy drill performance at minimum weight and cost. All BBS-1 combinations available with 24 or 30 h.p. Wisconsin gasoline or 32 h.p. diesel engine.



● **also BBS-1 Jr.**

All swivelheads illustrated are available on lighter BBS-1 Jr. model with 12 h.p. gasoline or 15 h.p. diesel engine. Capacities: "EW".....600 ft.
"AW".....400 ft.
"BW".....300 ft.

WE LOOK INTO THE EARTH

59-21

BOYLES BROS
DRILLING COMPANY LTD.
VANCOUVER, CANADA

DRILLS • BITS • EQUIPMENT • CONTRACTING
The World's Most Complete Diamond Drilling Service

BOYLES BROS. DRILLING CO. LTD., NEWCASTLE-ON-TYNE, ENGLAND • BOYLES BROS. (PTY.) LTD., JOHANNESBURG, SOUTH AFRICA
BOYLES BROS. (PTY.) LTD., KITWE, NORTHERN RHODESIA • ATLANTIC GULF & PACIFIC COMPANY OF MANILA, MANILA, PHILIPPINES
DR. ALBERTO BIANCHI, MILANO, ITALY • CIA. "DIAMANTINA B.H." S.A., LIMA, PERU • DIMITRY SCALISTIRI, ATHENS, GREECE
FORMAC S.A., RIO DE JANEIRO, BRAZIL • HAEHRE AND COMPANY, A/S, OSLO, NORWAY • ITEC, S.R.L., BUENOS AIRES, ARGENTINA
JOHANSSON & CIA., S.A., LA PAZ, BOLIVA • SHRIRO TRADING COMPANY S.A., TOKYO, JAPAN • TRILLIANCE ENGINEERING CO.
BOMBAY, INDIA • WIESE AND CA. LDA., LISBON, PORTUGAL.

139,500,000 LOW-COST TONS!

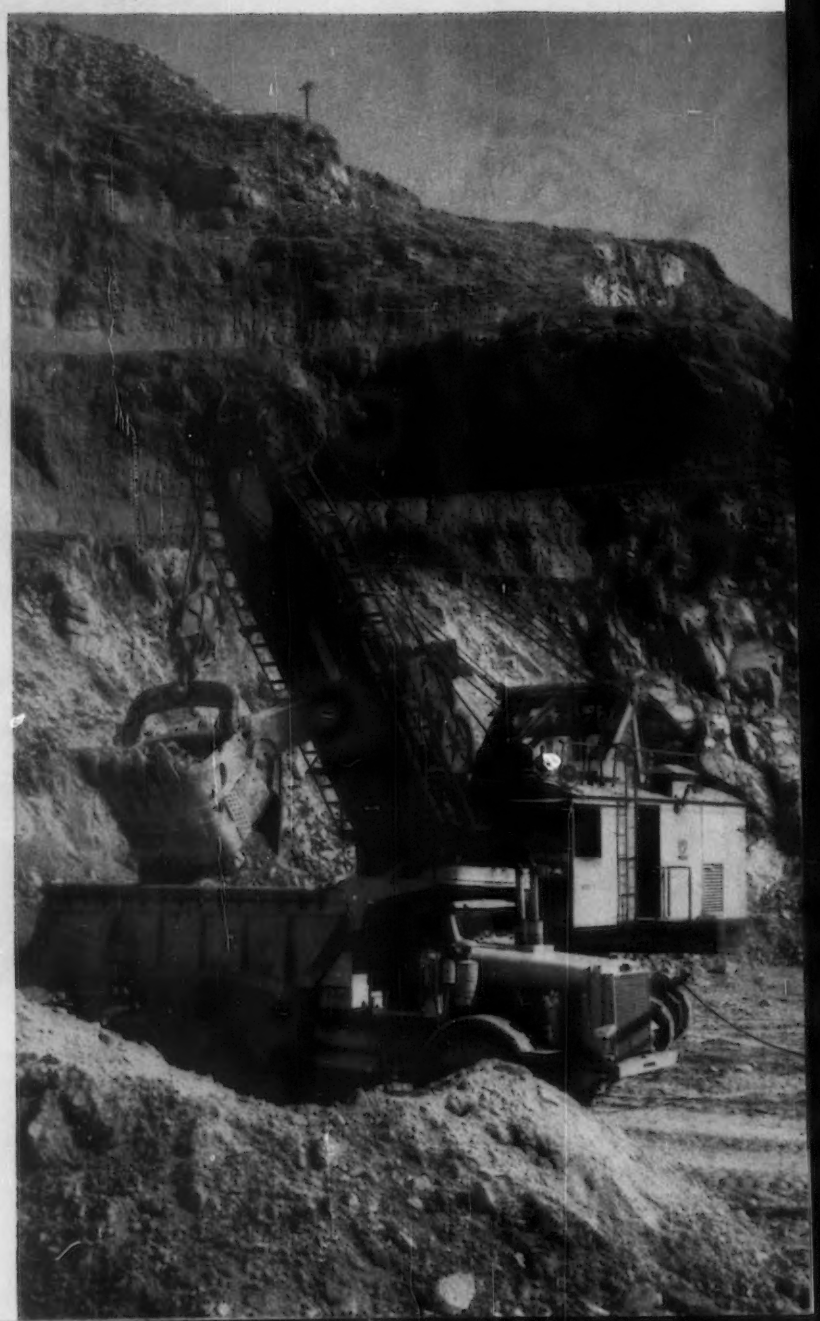
It is a documented fact that three Marion shovels have loaded more than 139,500,000 tons for the Miami Copper Company in the last 16 years.

This evidence of long machine life and dependability in continuous heavy-duty digging is only one side of the story of Marion mining shovels.

Today, new designs, new materials and new sizes of Marion mining machines are writing new chapters of low-cost, dependable efficiency.

Get the cost and output figures — not for just a day, but for years — and you will see why steady, low-cost tonnage, year after year, starts with

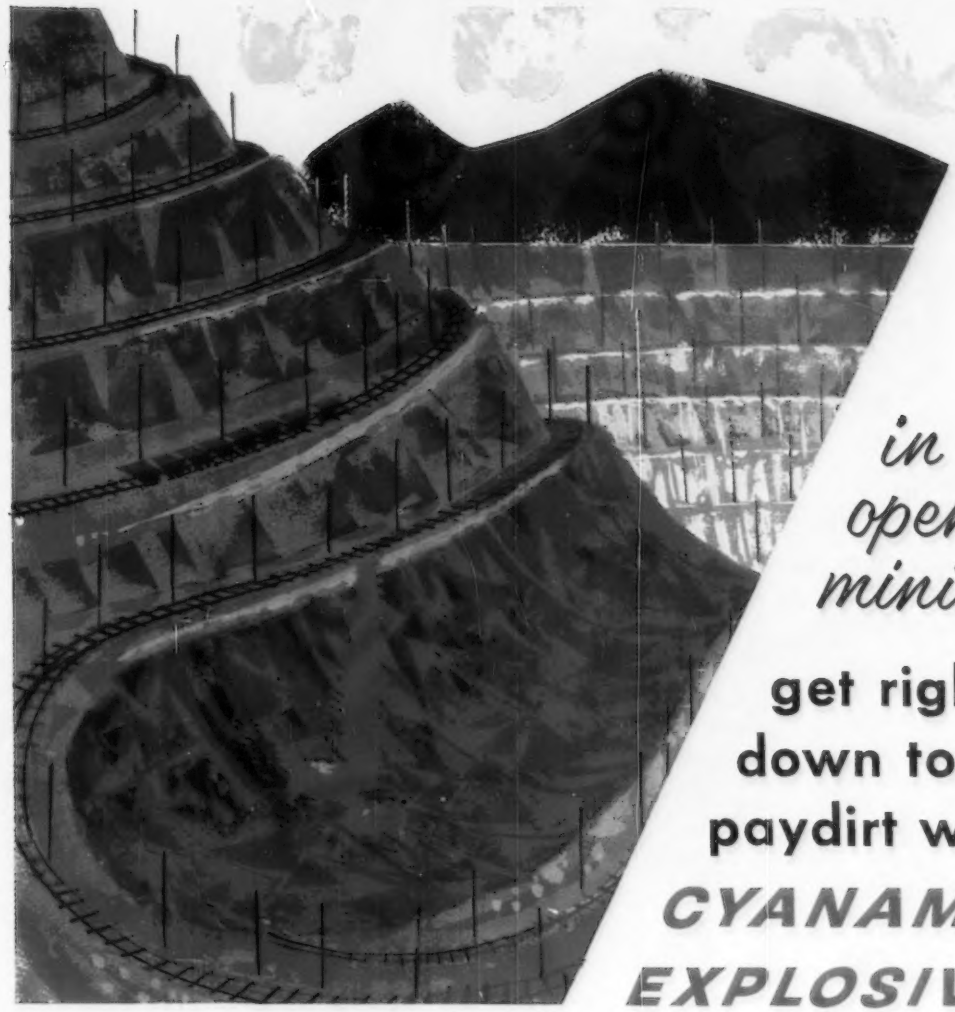
MINING MACHINES BY MARION



MARION POWER SHOVEL COMPANY

MARION, OHIO

A Division of Universal Marion Corporation



in open pit mining

get right down to paydirt with

CYANAMID EXPLOSIVES!

An experienced Cyanamid explosives engineer is always ready to help you improve blasting efficiency . . . by recommending the newest blasting techniques and helping you select the lowest-cost combination of explosives for your operation.

For every shot, there's a Cyanamid explosive designed to give you controlled breakage and economical handling! Prompt delivery, too, from a nation-wide network of plants and magazines.

Get the facts on Cyanamid's complete line of explosives and blasting accessories. Call or write our nearest office listed below.

CYANAMID

AMERICAN CYANAMID COMPANY

EXPLOSIVES AND MINING CHEMICALS DEPARTMENT

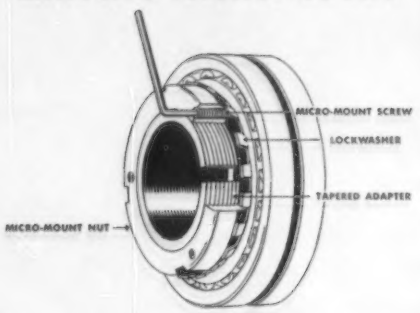
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

SALES OFFICES: Denver, Colorado • Maynard, Massachusetts • Kansas City, Missouri • St. Louis, Missouri • Albuquerque, New Mexico New York, N.Y. • Tulsa, Oklahoma • Latrobe, Pennsylvania • Pottsville, Pennsylvania • Dallas, Texas • Salt Lake City, Utah • Bluefield, West Virginia

PLANTS: Grafton, Illinois • Latrobe, Pennsylvania • New Castle, Pennsylvania • Springville, Utah

PRODUCTS: High Explosives • Permissibles • Seismograph Explosives • Blasting Agents • Blasting Caps • Electric Blasting Caps • Blasting Accessories

Exclusive MICRO-MOUNT



Fast and accurate mounting is made possible by the new Dodge Micro-Mount. The Adapter is snugged up with the Micro-Mount Nut. Mounting is completed by turning the Micro-Mount Screws against the Lockwasher until bearing, adapter and shaft form an integral unit.

NEW!

Spher-Align

SPHERICAL ROLLER BEARING PILLOW BLOCK

Dodge, the nation's leading supplier of mounted bearings, presents America's newest spherical roller bearing pillow block . . . a rugged bearing in attractive modern design . . . inherently self-aligning . . . easy to install . . . easy to maintain . . . and featuring the unique Micro-Mount.

Its rugged housing of close-grained semisteel withstands shock loads. It has a generous lubrication reservoir—for oil or grease. And standardized dimensions make Spher-Align interchangeable with all other similar units.

Expansion and non-expansion types. Stocked for 2 7/16" to 8" shafts. Call your Dodge Distributor—or write us.

DODGE
of Mishawaka, Ind.

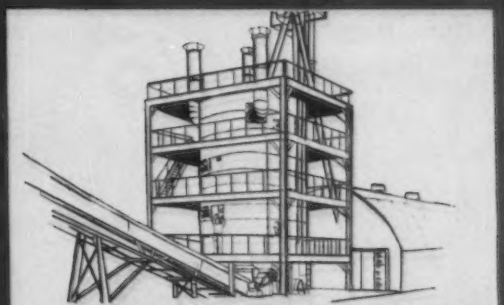
CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE MANUFACTURING CORPORATION
3100 Union Street, Mishawaka, Indiana

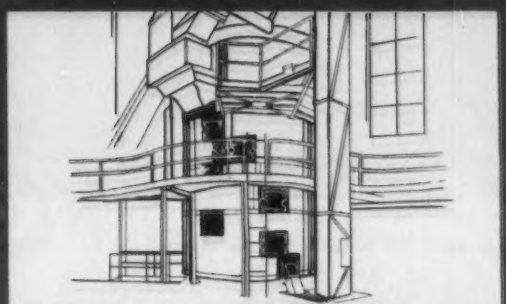
Processing Furnaces ..and Experience at Your Service

ROASTING NICKEL ORE IN CUBA

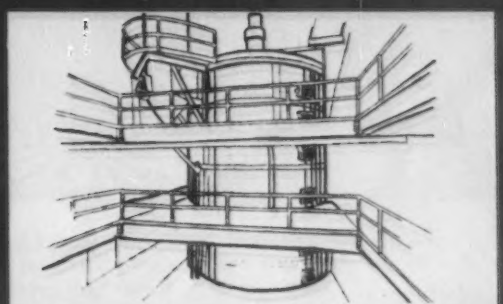
FLASH ROASTING PYRITES IN FRANCE



CALCINING KAOLIN IN GEORGIA



REGENERATING BAUXITE IN BRAZIL



DRYING/BURNING SLUDGE IN TENN.

The variety and scope of Nichols Herreshoff* multiple hearth and Nichols Freeman flash roaster applications abroad and in this country provide the necessary background of Nichols' thermal processing experience.

We invite you to consult with us. Pilot plant equipment and laboratory services available, as well as facilities for custom roasting and drying. Write for illustrated brochure No. 233.

NICHOLS

NICHOLS ENGINEERING & RESEARCH CORP.

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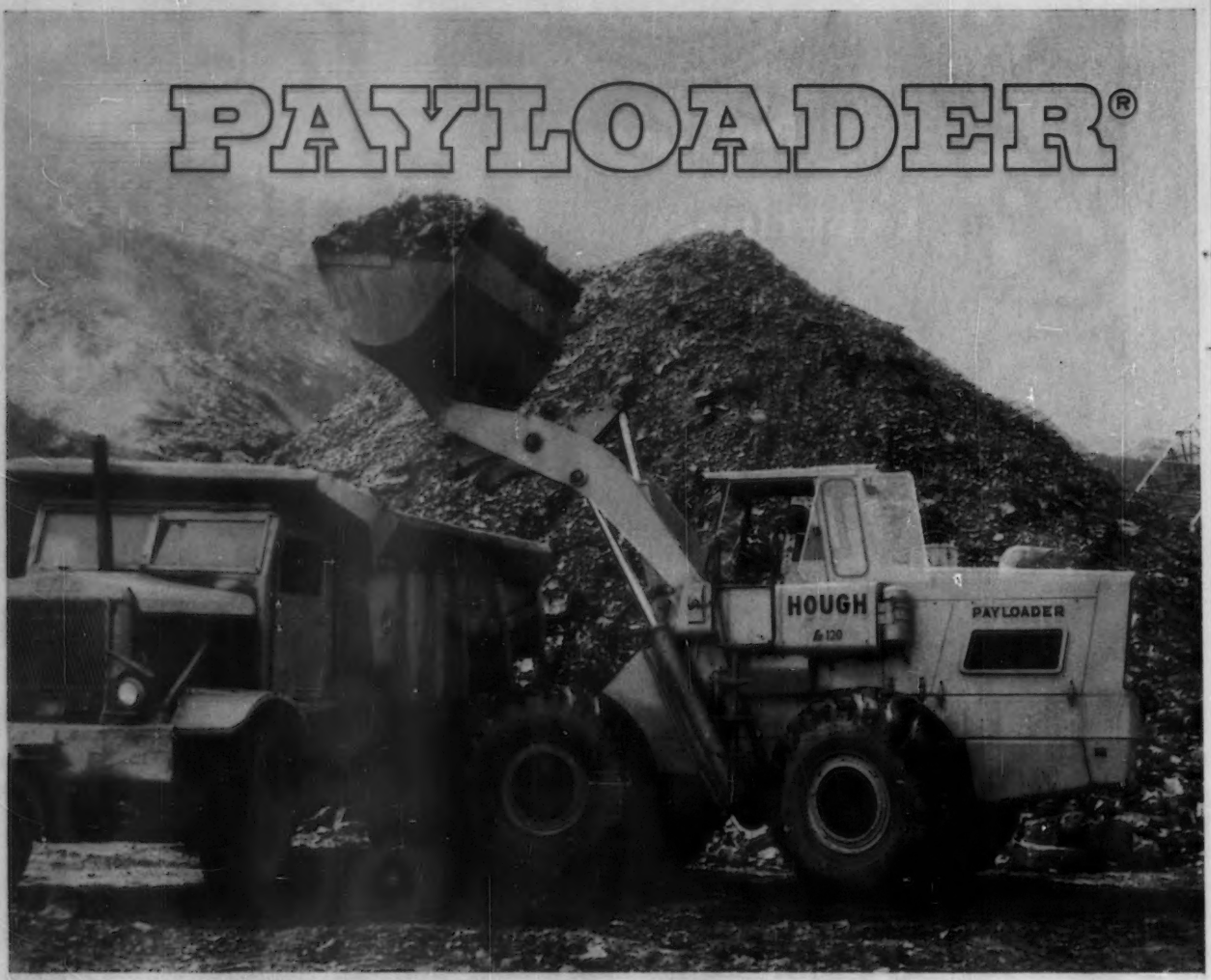
*Trade Mark of Nichols Eng. & Research Corp., Reg. U.S. Pat. Off. and in Canada.

PAYLOADER®



LOADING — Huge, fast Model H-120 is a big producer, with buckets ranging up to 6 cu. yd.

CLEANING SEAMS — "PAYLOADER" with 4-in-1 bucket cleans last 2-4 inches of dirt from coal seam "faster and with less coal breakage than any previous method" says Ohio River Collieries, Inc.

FEEDING SINTER KILN HOPPERS — from stockpiles and windrow mixes — also loads cars with sintered manganese. "We couldn't do without our 'PAYLOADER' machines," says Mohave Mining & Milling Co.

Here's how to make your manpower **MORE PRODUCTIVE**

"PAYLOADER" tractor-shovels are being used many ways to boost tonnage and lower costs-per-manhour because they do so many jobs best, because they are available in so many models and sizes, and because of the many special-purpose attachments available for them.

Mines of all kinds — strip and underground, metal and coal — as well as smelters, refineries and processing plants, are taking advantage of "PAYLOADER" versatility for both production and maintenance phases of their operations. From the unloading of boxcars (1¼-tons per pass), to the loading of large haulage units (at 12,000 lbs. of material per pass) there is a range of eight "PAYLOADER" sizes, including 4-wheel-drive and 2-wheel-drive types to fit varied needs and production requirements.

Any "PAYLOADER" you buy gives you more than a tractor-shovel because it is a member of the pioneer and leadership line — the standard of comparison by which all other rubber-tire tractor-shovels are scored. Your "PAYLOADER" Distributor is also a member of the most experienced network of distributors in the industry. He is ready to help you match "PAYLOADER" units to their profit-making applications in your company.

HOUGH, PAYLOADER, PAYMOVER, PAYLOGGER and PAY are registered trademark names of The Frank G. Hough Co., Libertyville, Ill.

UNDERGROUND — Can load ore directly into haulage units, or carry and dump into chutes. Diesel power with exhaust scrubbers available.

SWITCHING, SPOTTING CARS — also loads, feeds conveyor and stockpiles at C & P Coal Co. "We use it for everything," says D. M. Love.

HOUGH®

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY — INTERNATIONAL HARVESTER COMPANY

THE FRANK G. HOUGH CO.
726 Sunnyside Ave., Libertyville, Ill.

Send data on "PAYLOADER" models and attachments for Mining.

Name.....

Title.....

Company.....

Street.....

City.....State.....

12-8-5

Harbison-Walker monolith-

Economical methods for durable constructions

Casting H-W Extra Strength Castable, as in this flue arch, is an easy and time-saving method.

Gunning H-W castables has certain application advantages which save maintenance time and furnace availability.

THESE LONG-ESTABLISHED LEADERS CONTINUE

Harbison-Walker has more than two-score different castable refractories, plastic fire brick and ramming mixes of conventional classes and various modifications especially adapted for new specific uses. In composition they span all the usual refractory oxides, stabilized natural and synthetic minerals, from the most definitely acid to the most strongly basic. These chemical properties, together with the physical characteristics in the combinations best suited for severe operating conditions in metallurgical furnaces, provide the refractories for best economy.

In accordance with the best practice for the particular purpose, Harbison-Walker monolith-forming refractories are installed by various methods —such as pouring or tamping, troweling or gun-placement—depending upon the product and its application. For many purposes, they are used for complete linings free of joints, for maintenance in making both small and very large patches. Special shapes for emergency or prompt needs can be fabricated for immediate use.

Several applications of special interest are here briefly described:

The use of **H-W EXTRA STRENGTH CASTABLE** is highly successful in multiple hearth roasters, fluidized solids reactors and subbottoms of invert arches in various refining furnaces.

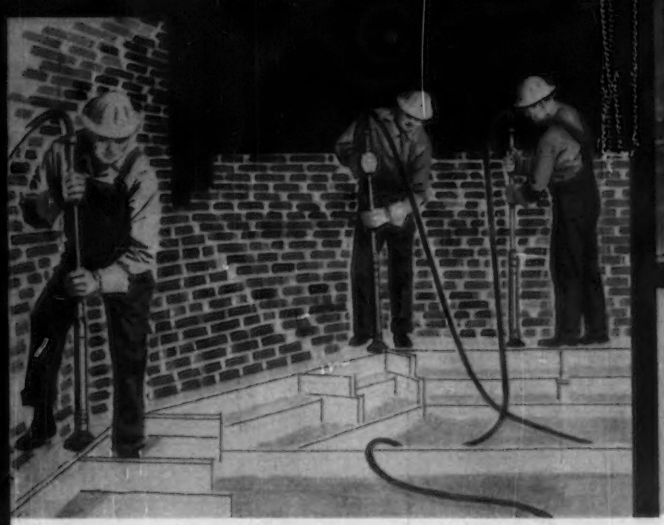
CHROMEPAK, the highly basic castable having great resistance to erosion, is proving its good serviceability in charge-hole positions of reverberatory copper smelting furnaces. In a specific modification, it holds particular promise of serving for tuyere patching and for center sections of electric furnace roofs which otherwise involve costly cutting and fitting of brick shapes.

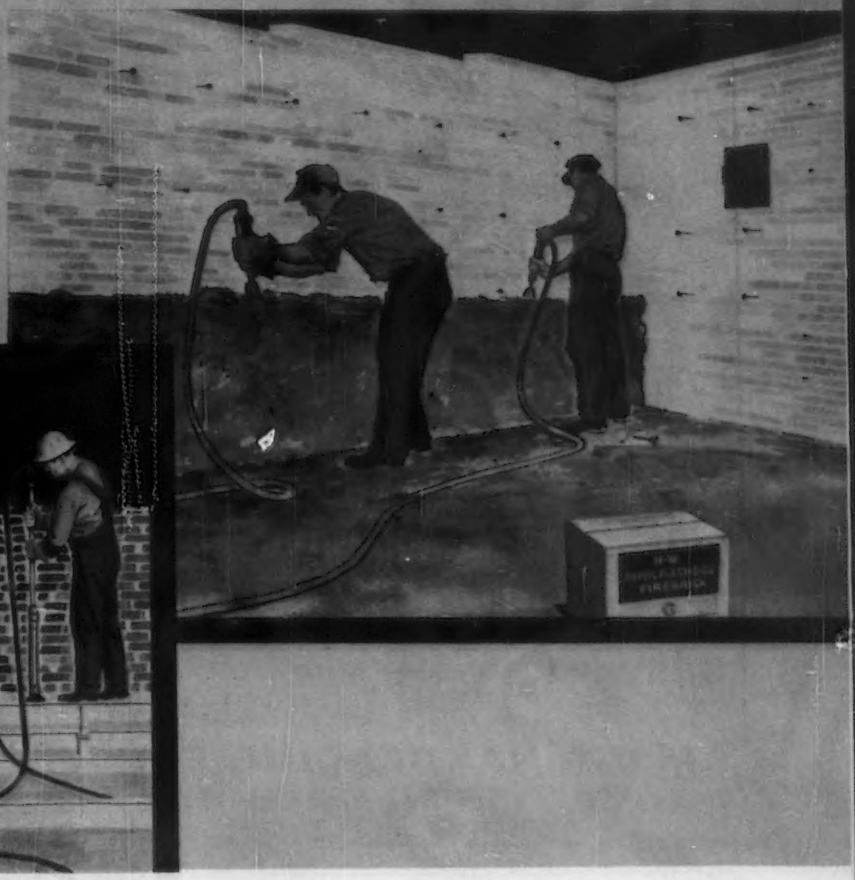
forming refractories

. . . *for metallurgical furnaces*

Ramming H-W Super Plastic-CS lining in a side wall, prior to setting first row of refractory anchors.

Contour-ramming furnace bottoms with H-W C-Mix reduces furnace downtime and saves labor.





MAKING MANY EXCELLENT SERVICE RECORDS

CORALITE (22-58) RAMMING MIX, in the class of 85% alumina refractories, is a development particularly for use in contact with molten aluminum and its many alloys. When rammed into place and heated to a temperature approaching the melting point of aluminum, it becomes exceedingly strong and resistant to mechanical abuse which frequently accompanies the charging of cold metal into the furnace. This specialized ramming mix is particularly adapted for use in lower side wall construction because of its resistance to penetration and corrosion by molten aluminum alloys. As used in side walls, the usual dross formation does not readily adhere and accumulate as accretions which interfere with furnace operation.

H-W C-MIX is a high purity stabilized periclase product which now is used principally for contour-rammed open hearth and electric furnace bottoms. Its use greatly reduces furnace downtime, saves labor and avoids burning-in sacrifice of refractory superstructure.

The many types and classes of these Harbison-Walker refractories include lightweight insulating products, special gunning mixes for maintenance and others of compositions and properties best suited for use in contact with molten aluminum in the many alloy compositions, lead and zinc as well as various other nonferrous metals.

Please write for complete detailed information for the various uses of special interest.

HARBISON-WALKER REFRACTORIES COMPANY

AND SUBSIDIARIES **GENERAL OFFICES: PITTSBURGH 22, PA.**

World's Most Complete Refractories Service

Leadership in Refractories Through Constant Research

The Garber Research Center

How AMSCO helps you MOVE

Read why AMSCO Simplex Teeth and hardfacing are first choice of these users

SIMPLEX TEETH STAY SHARP AFTER 20,000 TONS OF DIGGING

AT VICTORVILLE LIME ROCK CO.

At Victorville Lime Rock Co., Victorville, California, four Amsco Simplex 2-Part Reversible Teeth were installed on a shovel used in a stripping operation. Teeth previously used "lost their points" after digging about 18,000 tons of rock... and had to be replaced or rebuilt. The Simplex Teeth have already dug over 20,000 tons. Paul Keating, Quarry Superintendent, expects to get *at least 25,000 tons* before changing teeth.

Wright Smith, operator of the strip shovel, is equally enthusiastic about Simplex Teeth. He says they can lose more than 2" due to wear, and still hold their points. This means lower cost operation and fewer shutdowns for maintenance. Old-style teeth had to be sent out for welding when worn down a couple of inches.

Victorville Lime Rock Co. produces a pure white lime rock used as an extender or filler in paints, plastics, floor tiles, rubber, ceramics, etc. They operate a 100 ft. deep quarry, and plan to switch to Simplex Teeth on their other production shovels, too, in order to save on maintenance costs.

AMSCO HARDFACING ELECTRODES PROVE BEST FOR BUILD-UP JOBS

AT BAY CONTRACTORS WELDING SERVICE

"Amsco AW-79 wire doesn't twist and gives an excellent, uniform bead" —says Peter Agresta, partner in Bay Contractors Welding Service, El Cerrito, California. He also adds that AW-79 gives service life equal to, or better than, any wire they've ever used.

As a result, Bay Contractors uses Amsco AW-79 (a highly quality-controlled tubular rod) for just about every type of build-up job... except where surfaces require machining.

For example, they use it for build-up of diesel switcher wheels... crawler tractor rollers and idlers... shovel rollers and front take-up rollers... house carrier rollers... sheaves... cutting edges on all alloyed blades.

For further information:

SIMPLEX TEETH—see your power shovel equipment dealer, or write Amsco for technical bulletin.

HARDFACING ALLOYS—see your Amsco welding distributor, or write direct for Condensed Catalog and Price List.

AMSCO

American Manganese Steel Division • Chicago Heights, Ill.

Other plants in: Denver • Los Angeles • New Castle, Dela. • Oakland, California • St. Louis
In Canada: Joliette Steel and Manitoba Steel Foundry Divisions
Welding products distributed by Canadian Liquid Air Co., Ltd.

AMERICAN Brake Shoe COMPANY

Drillers get "more hole per hour

MORE TONS PER DOLLAR

← Northwest Model 6 shovel, equipped with Amsco dipper and Simplex Teeth, used for stripping operations at Victorville Lime Rock.

→ Wright Smith, shovel operator (left) and Paul Keating, Quarry Superintendent (right) examine Simplex Teeth on Amsco dipper . . . after some 20,000 tons of digging.

→ Peter Agresta, of Bay Contractors Welding Service, uses automatic machine of own design to build-up tractor idler.

← Build-up of crusher jaw plate is demonstrated by a Bay Contractors' welder . . . Manganese rounds are first tack-welded across surface of plate with Amsco Nicro-Mang. Amsco Manganese Rod is used in the Amsco semiautomatic machine to build-up plate to original cross-section. The plate is then straightened by a special process.

Drillers get "more hole per hour with a REICHdrill" because . . .

ALL-HYDRAULIC TOP-DRIVE MEANS:

1. **Infinitely variable speed** of drill rotation from zero rpm to maximum rated speed of model – permits the right rotational speed for every formation.

2. **Safety torque release** which practically eliminates all chance of drill breakage . . . protects all drive components.

3. **Direct-drive to drill stem** eliminating power loss . . . no complicated transmission to wear or maintain . . . no rotary table.

4. **In and out of the hole faster** because no kelly is required.

5. **Operator can drill up as well as down** should bit become stuck.

when you run a Reichdrill you've got an all-hydraulic rig that features top-drive

And the REICHdrill offers these outstanding advantages: Dependable heavy duty CP Compressors supply plenty of air to suit demand . . . Fast-acting, ram-type hydraulic levelling jacks . . . CP "Air-Blast" Bits give you extra footage in the toughest formations . . . Angle drilling – operator simply sets correct angle and drills.

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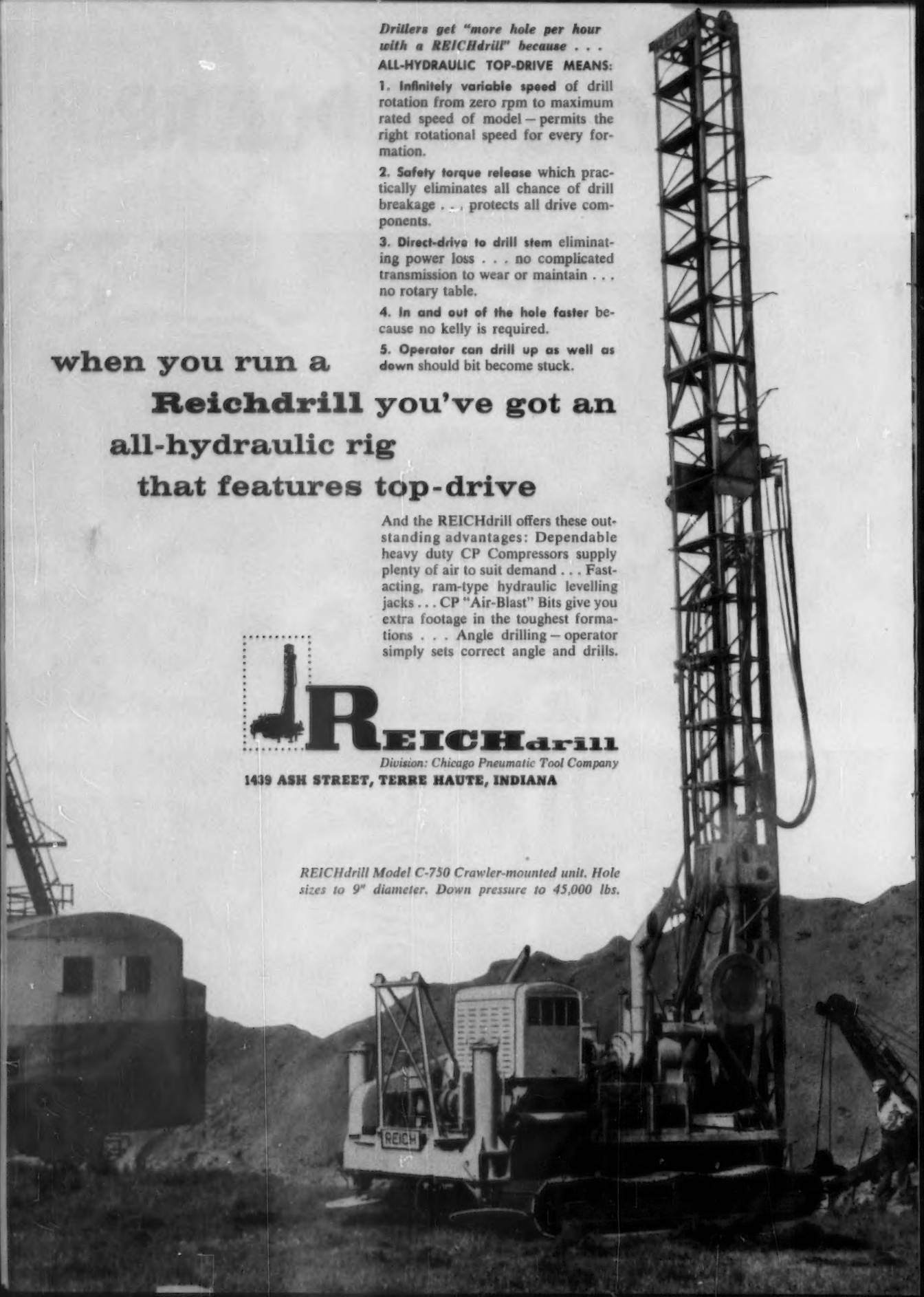
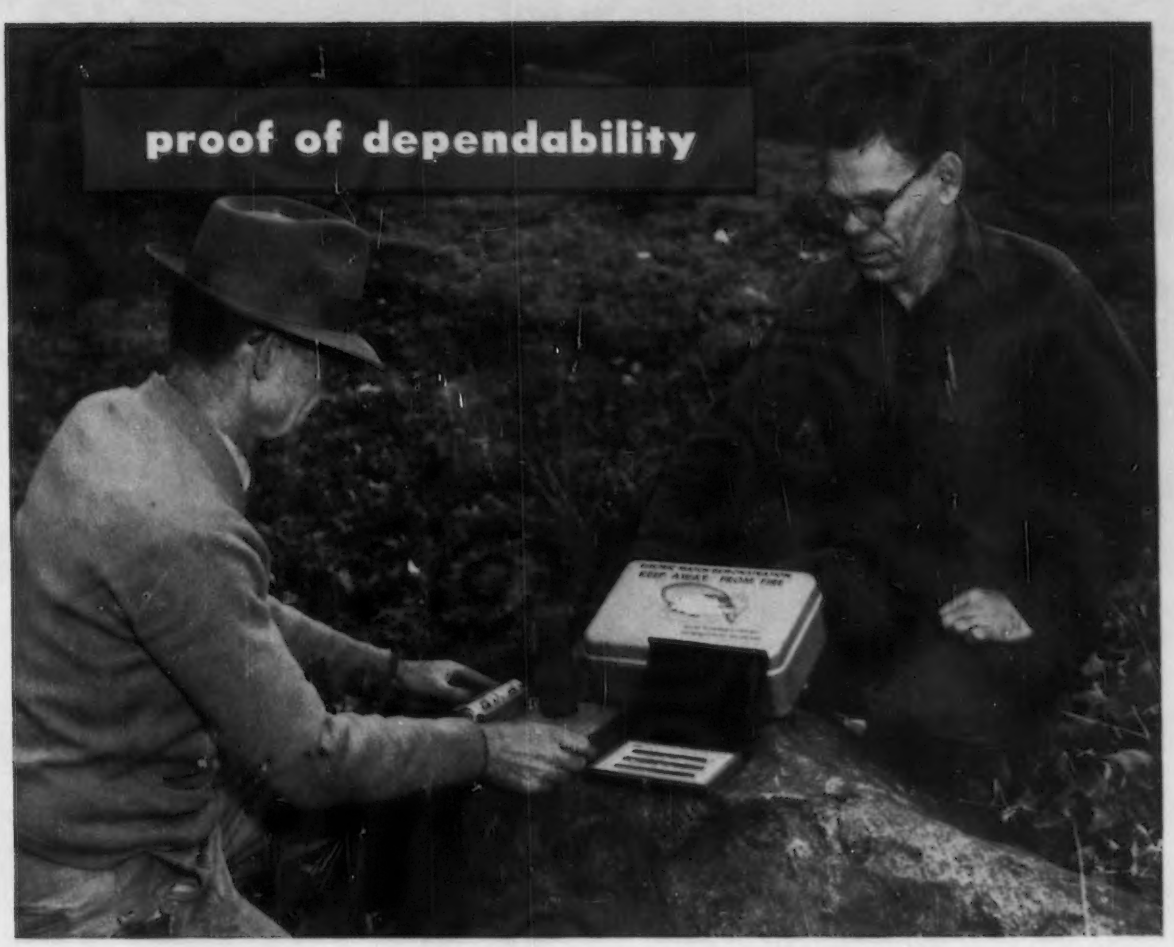


REICHdrill Model C-750 Crawler-mounted unit. Hole sizes to 9" diameter. Down pressure to 45,000 lbs.



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Your Atlas man can show you *why*, too. Every part of every Atlas match is pre-tested, and the match is completed by multiple dips in high quality flash compounds.

Your Atlas representative will be glad to show you this demonstration, and to help you use Rockmaster and regular Atlas E.B. Caps for dependable initiation and timing to get effective, economical blasting.

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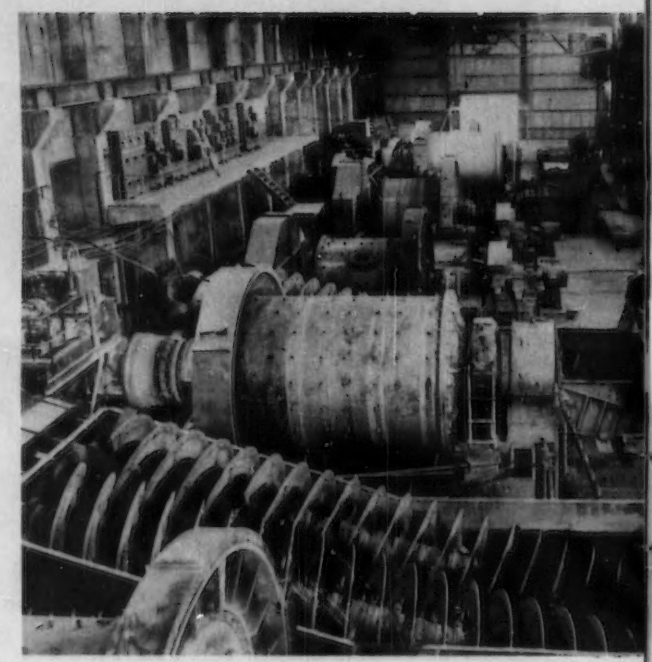
IRELAND...

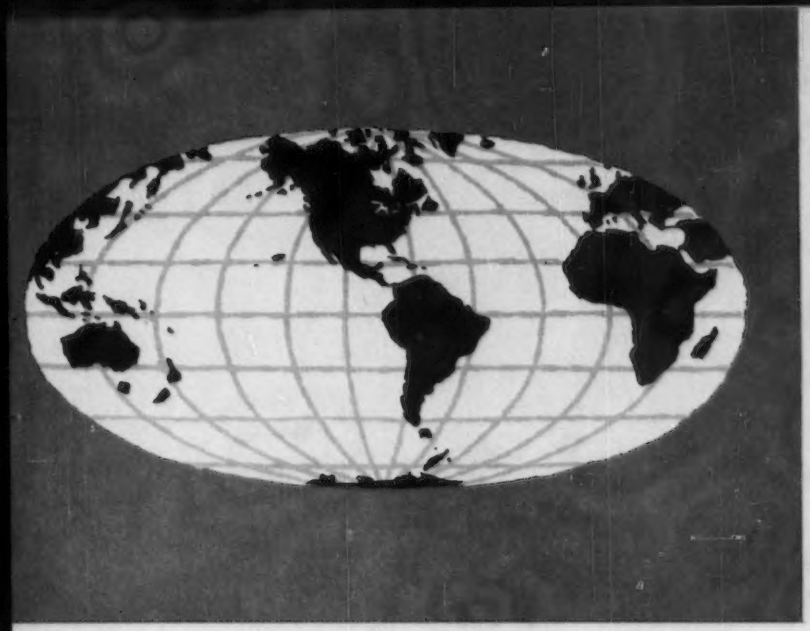
ST. PATRICK'S COPPER MINES

6 MARCY MILLS

St. Patrick's Copper Mines, Ltd., Ireland, has two 9′ x 12′ Marcy Rod Mills and four 9′ x 9′ Marcy Ball Mills. There are two grinding sections, each one having a rod mill in open circuit, discharging to two ball mills in closed circuit with two 72″ Akins Duplex Classifiers. Rod mill feed is minus ½″ and ball mill product is minus 120 mesh. Each section handles 2000 tons per day.



Pegson Limited, Coalville, England, a licensed manufacturer and sales agent for Mine and Smelter, manufactured and serviced the Marcy Mills. The Akins Classifiers were manufactured and serviced by Head Wrightson and Co., Ltd., Stockton-on-Tees, England, also a licensed manufacturer and sales agent for Mine and Smelter.



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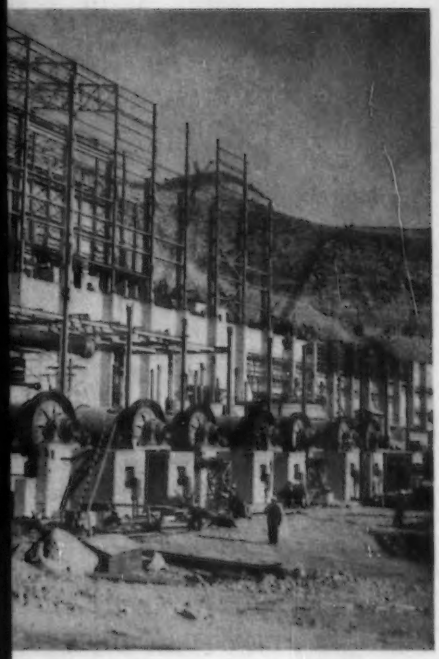

PERU...

SOUTHERN PERU COPPER CORPORATION

14 MARCY MILLS

Southern Peru Copper Corporation has seven 10′x14′ Marcy Rod Mills and seven 8′x13′ Marcy Ball Mills. Photo shows the ball mill section during mill construction. Each rod mill is to handle 184 tons per hour of minus 1¼″ feed, grinding to approximately 8 mesh. The ball mills will be used for regrinding concentrates. Each ball mill will be handling 700 tons per day with feed 55% minus 325 mesh, grinding to 85% minus 325 mesh.

South Pacific Industrial Supplies S.A., Lima, Peru, is Mine and Smelter's sales agent in Peru.

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Four Michigan Tractor Dozer models are now available . . this 165 hp size, 262 hp, 335 hp, 600 hp.

Rock quarry cuts repair bills 60%

Company records show rubber-tire Michigan Dozer also has reduced cleanup time 50% over track-type machines

"Like many other stone quarries, we sure used to be unhappy about track maintenance," says G. E. McLeer, vice president, Ohio River Stone Co, Prospect, Kentucky. "Rails alone used to cost us hundreds of dollars per year for replacement . . . plus several man-days of labor per change. No more. Our rubber-mounted Model 180 Michigan Tractor Dozer has run a year now. Naturally, no track problems . . . and no tire replacement either. Looks like original treads will last another year easily. Then, we expect to recap . . . and repeat recap. The savings should be at least 60%."

Excellent performance of Michigan Tractor Shovel echoed in Dozer

"Track wear wasn't the only reason we changed over," McLeer continues. "We chose the Michigan *Dozer* because of our excellent experience with our three Model 175A Michigan Tractor *Shovels*. Their all-Clark power trains really stand up. The Dozer's power train does, too. In its year of operation, the dozer has lost maybe 25 working hours—but that's all!

¼ mile move takes 2 minutes

"Production was another of our aims. The Michigan gets around much faster than the crawlers. In emergencies, for instance, we drive it the 20 miles between our two main quarries under its own power. After all, it's got a top speed of 27 mph, with good visibility, good brakes and power steering.

"Moves in any one quarry aren't nearly as long, but they're virtually continuous. Typical ¼-mile trip takes only 2 minutes . . . half to a third of crawler time. And, of course, the saved minutes go into productive work so necessary with increasing production demands.

"Our time studies show the rubber-tired Dozer *moves more material* on almost all jobs too — 50 per cent more when dressing stockpiles than a track-type machine. The reason? The Michigan moves *just as much* with its 10-foot dozer blade *per load*, yet *moves more loads per hour*. Speed advantage is mostly in faster backup, faster shifting. You don't have to stop to change speeds; just move a short-throw lever. No foot-clutching is necessary, ever."

Jack-of-all-jobs

Michigan Model 180 Tractor Dozer is "work-horse" of the main Derby Company quarry. Unit:

1. Takes about ½ hour to clean quarry floor after each shot.
2. Three to four times a day cleans up around two shovels: one on rock, one on stripping. Total work time, about 1½ hours per day.
3. Once a day, cleans spillage from 2 miles of truck roads.
4. Cleans spillage under crushers and aggregate bins.
5. Shapes nine rock stockpiles.
6. Cleans rock and dirt after stripping and before drilling.

Distributor service praised

"If any of our Michigans go down, we call our distributor (Emmett C. Watson Co of Louisville), and his men come right out," says McLeer. "Very seldom do we have to wait for parts and we get good warranty service."

You can get the same fast, low-cost help from *your* Michigan Distributor. Their good service is an important reason for the sale of over 8,000 Michigan rubber-tire units since 1954. Call them soon . . . they're good friends to know.

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You can make your present lube rig twice as valuable as it ever was before – with a Texaco Simplified Lubrication Plan. Here's how:

A Texaco Plan can cut your total inventory from a dozen or so products down to six or less. Your mobile rig is then equipped to handle *all* major lubrication on *every* piece of equipment.

A planned inventory of only six lubricants can save you money every time you service your equipment. Application routine is simpler, with far less chance of using the wrong lubricant. And you save valuable manhours because low inventory minimizes handling, storage, and extra paperwork.

Call a Texaco Lubrication Engineer *now*. Let him show you how Texaco Simplified Lubrication can keep your equipment in top-notch condition at the lowest possible cost. Call the nearest of the more than 2,300 Texaco Distributing Plants in the U. S., or write Texaco Inc., 135 East 42nd Street, New York 17, N. Y.

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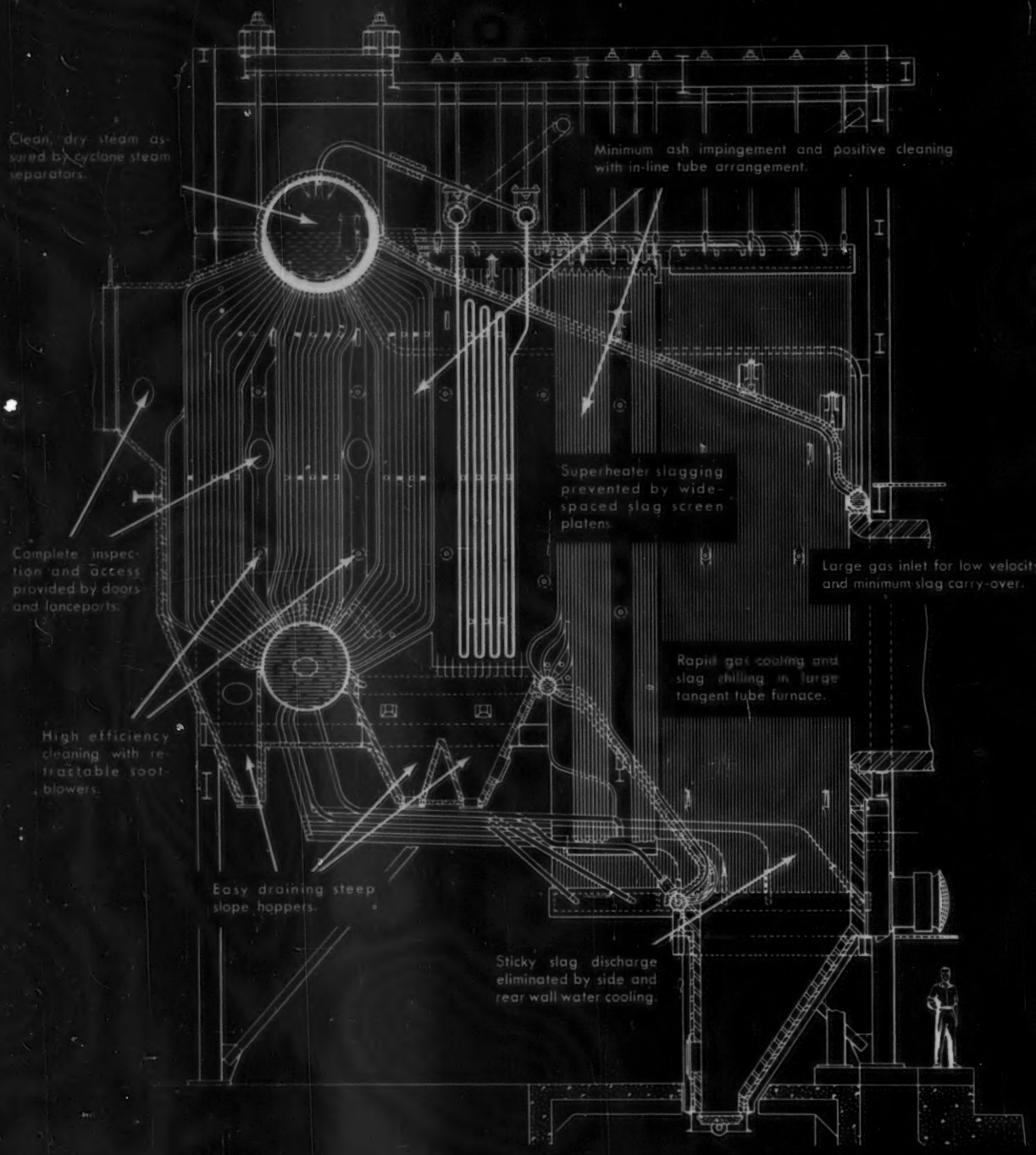
Clean, dry steam assured by cyclone steam separators.
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High efficiency cleaning with retractable soot-blowers.
Easy draining steep slope hoppers.
Sticky slag discharge eliminated by side and rear wall water cooling.

These important design features assure trouble-free, continuous operation of this B&W Waste Heat Boiler

Empresa Nacional de Fundiciones, Paipote, Chile, uses this B&W Waste Heat Recovery Boiler to produce 42,500 lb steam per hour at 400 psig and 700 F at the superheater outlet.

HOW TO SOLVE WASTE HEAT BOILER PROBLEMS

B&W heat recovery system ends production bottleneck

A major problem in waste heat boiler operation is the fouling of steam generating surfaces by slag and ash from the process. Frequent outages and excessive labor for boiler cleaning add substantially to the cost of any plant operation. Production delays can result in further serious losses.

For example, the Empresa Nacional de Fundiciones copper smelter at Paipote, Chile was experiencing difficulty in handling high temperature corrosive gases with considerable slag and metallics carryover. Slagging of boiler surfaces was severely limiting plant production. Unscheduled smelter shutdowns resulted in excessive refractory maintenance, high operating costs, and production losses.

B&W's engineers were asked to design a boiler to provide trouble-free operation for these difficult ash and slag conditions. An important requirement was that the new system be installed without interrupting plant operation. Utilizing the extensive experience gained from similar installations, B&W recommended a special, single pass, low draft loss boiler for the specific plant conditions at Paipote. B&W's recommendations for a completely engineered system were accepted and a waste heat boiler, flues, dust handling equipment, and auxiliaries were furnished.

The successful elimination of the waste heat handling problems, previously limiting production and causing high maintenance costs, has now been proved by several months of operation. In fact, plant production is now above design capacity.

B&W's extensive research and engineering facilities, plus its broad field experience in design and operating requirements in the metallurgical process industry, are available to solve your problems. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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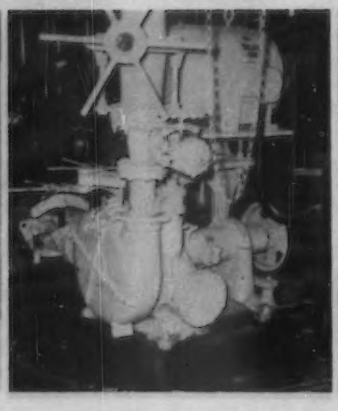

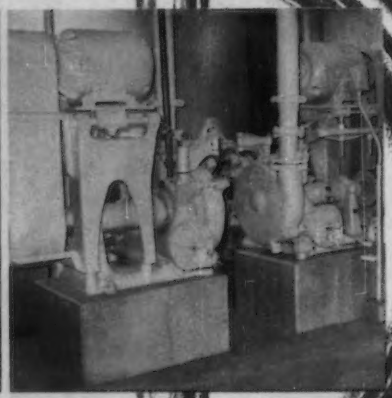

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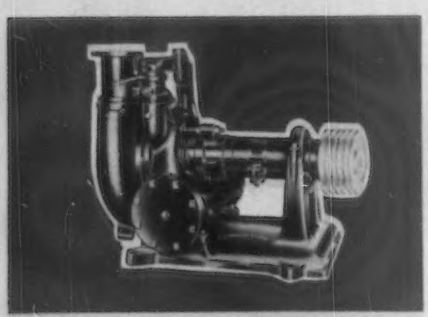

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ENGINEERING AND MINING JOURNAL

DECEMBER 1959

H. C. Parmelee, 1875-1959

DR. HOWARD C. PARMELEE, former McGraw-Hill vice president, editorial director, and for 13 years editor of ENGINEERING & MINING JOURNAL, died Nov. 17, 1959 at Bradenton, Fla.

During an active and many-sided career, Dr. Parmelee had also been, among other things, president of the Colorado School of Mines and the American Electrochemical Society.

He was born in Omaha, Neb. in 1875 and received his bachelor's and master's degrees in chemistry from the University of Nebraska. He taught there for two years and worked for three years more in the field before joining McGraw-Hill in 1910. He received his honorary doctorate from Colorado School of Mines.

For 36 years he served McGraw-Hill, first as editor of CHEMICAL & METALLURGICAL ENGINEERING, which later became CHEMICAL ENGINEERING (1917-1928); as vice president and editorial director (1928-1933); and then, as successor to A. W. Allen as editor of E&MJ, the post he held until his retirement in 1946.

Although Dr. Parmelee will most certainly be remembered by a great many people in many widely scattered professions, he is most honored by the processing industry for his pioneer work in the movement to accredit chemical engineering education. That effort was honored in 1956 by the American Institute of Chemical Engineers.

Dr. Parmelee literally grew up in the mineral processing industry in the West, with such contemporaries as Dorr and Oliver, M. C. Whitaker and Moore. He worked alongside Acheson, Baekeland, Dow and Hooker. His association with the mining industry leaves a vast number of friends who will mourn his passing, and leaves this magazine with a sense of loss at his parting and gratitude for the professional and human integrity which is his true legacy.

The Challenging '60s

BUSINESS ECONOMISTS, who have appraised the strength and momentum of American industry, tell us that we may look with confidence for continued growth and healthy expansion during the next decade.[1] They also tell us that industry and government will have to cope with drastic changes in economic climate. One storm signal, for example, warns of competition from foreign industrial centers which have emerged from the rubble of war into amazingly modern productive units, unburdened with the obsolete equipment which surveys show is common in many U.S. plants.

One solution to this problem rests squarely with Congress. Comparisons of the depreciation allowances in our tax laws with those of Canada and most other industrial nations of the world show that our laws are archaic because they fail to acknowledge inflation and the increasing cost of replacing obsolete equipment. Coupled with the Government move will have to be a willingness of labor to cooperate with management in fighting competition.

For the mining industry, another storm signal hangs high—the impact which research, science and engineering will have on markets and technology. This team can create, scramble or wreck markets.

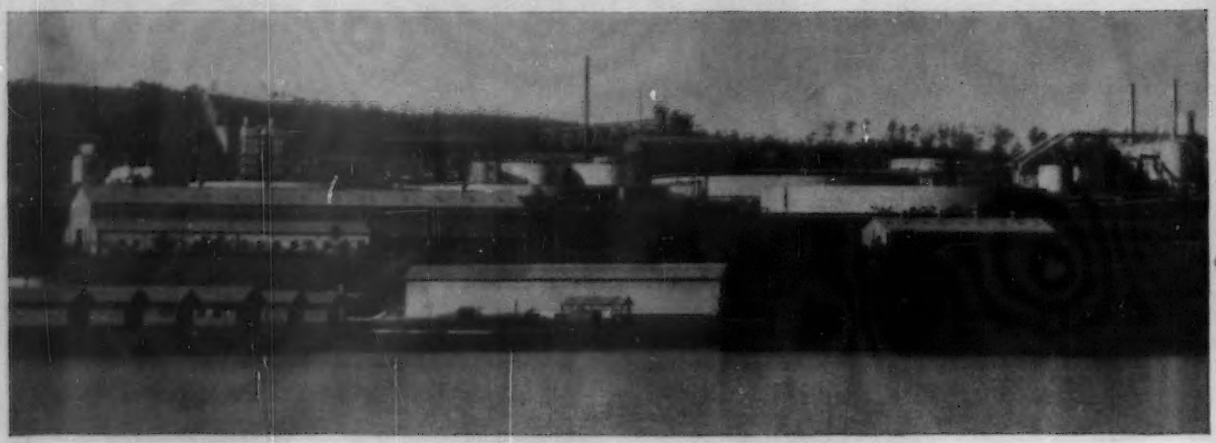
Take the fuel cell for instance. The '60s will undoubtedly see the development of this revolutionary new source of electric power. (E&MJ, November p168). Then there's the Peltier-effect electronic heating and cooling development, using ultra high purity metals. (October, p17).

The challenging '60s may bring in the mining of manganese from the bottom of the sea; exploitation of massive ore deposits by atomic explosions, direct-reduction of iron ores, which could reorient the entire iron-ore mining and steel making industry; extraction of metals from the sea and other dilute solutions by ion exchange or massive flotation; production of alumina and other commercial products from clay, anorthosite or syenite; the electro-magnetic fragmentation of ores in mines and mills; and perhaps a beryllium boom. For the billion-dollar-a-year uranium ore industry, we hope to see a speed-up in the application of atomic energy for process heat, power, conversion of salt water to fresh, and other commercial uses.

On the economic front, mining companies will tend to become larger, more integrated and more diversified. We believe that the Justice Department will have to consider seriously whether it will pursue the same anti-bigness policies that may have been necessary in the '30s, but may be harmful in the '60s. One reason for this is the threat of competition from the government-monopolized industries in the Communist world. It's exceedingly doubtful whether American industry will be able to compete successfully in world markets, straight-jacketed by Government regulation, archaic depreciation tax provisions, and unsympathetic labor monopolies while Russia is free to commandeer labor, fix prices, and shunt production in any direction it wishes to engage in trade wars.

Whatever else the '60s may promise, we can be sure that industrial leadership is going to have to apply greater foresight, sagacity and agility than in any previous decade. In this period of progress and change, the engineer-science team will probably be the most disturbing influence—for good or for bad.

[1] "New Forces in American Business" by Dexter M. Keezer. McGraw-Hill Book Co., 330 West 42 St., New York 36, New York.



MOA BAY'S layout includes warehouses, H and H_2S plants (back) gypsum thickeners, the precipitation plant, ore slurry

Freeport Nickel's Moa Bay Puts Cuba Among Ranking Ni-Producing Nations

CUBA IS NOW the second-ranking nickel nation in the world.

From a shaded area on a lease map in 1940, to a sideline investigation by a chrome exploration party in 1951—a pilot plant in 1953 and metal production tests in 1954 and '55, Freeport Nickel Co. has built a $119-million nickel-cobalt-ammonium sulphate project, now ready for production.

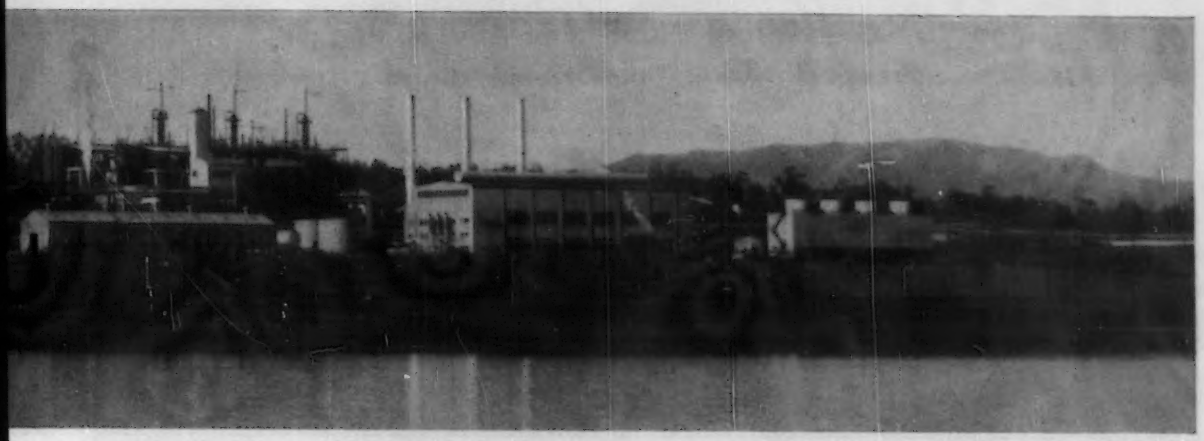
The original lease was in the Oriente Province of Cuba, obtained at the same time as Freeport's Nicaro lease which supplied ore for the Nicaro plant and for the U.S. war effort from 1943 until 1947, when the plant was closed down by its owners, the U.S. Government. (Nicaro was reopened to serve during the Korean Crisis, and is still producing under U.S. Government operation at a rate of about 27,000 tpy).

The exploration party in 1951 consisted mostly of Richard V. Colligan, now president of Moa Bay Mining Co., who went in to look for chrome, but found the lateritic iron ore more attractive. Colligan returned in 1952 with Gerardo Jimenez, David Daquin, B. F. Darnell and Hal Kristjanson, and prospecting began in earnest. The orebody they studied has proved to contain more than 50-million tons of low-grade lateritic iron ore, with 1.36% Ni and 0.13% Co. It also contains copper, zinc, aluminum and small amounts of manganese and chrome (E&MJ, September 1957, p 78).

MINING THE RED ORE by 2½- and 5-yd draglines is simplified for the operators by lime-marker cutoff points at the top of the ore and different colored bedrock.

The pilot plant in 1953 was a 10-tpd operation at Freeport's facilities in Hoskin's Mound, Tex., where research in bench-scale autoclaves had been underway since August 1952 on the low-magnesium ore. It was the latter characteristic which offered attractive commercial production from Moa Bay as opposed to Nicaro, whose ores were high in magnesium, and required ammonia leaching. With Moa Bay's ore, sulphuric acid could be used. Chemical Construction Corp. was developing a process at the same time that Freeport was conducting its research on separating the nickel and cobalt metals from the complex laterites and in early 1953, Freeport obtained exclusive rights to the Chemico process for treating U.S. and Cuban ores.

The Hoskins Mound plant added some process refinements of its own, and went to work on 300 representative tons of Moa ore. By January 1955, the method was proved up and Freeport had obtained a purchase contract with the U.S. Government covering about 135,500 tons of nickel metal and approximately 12,000 tons of cobalt. The Government also has the right to require delivery of 30% of the new plant's output.

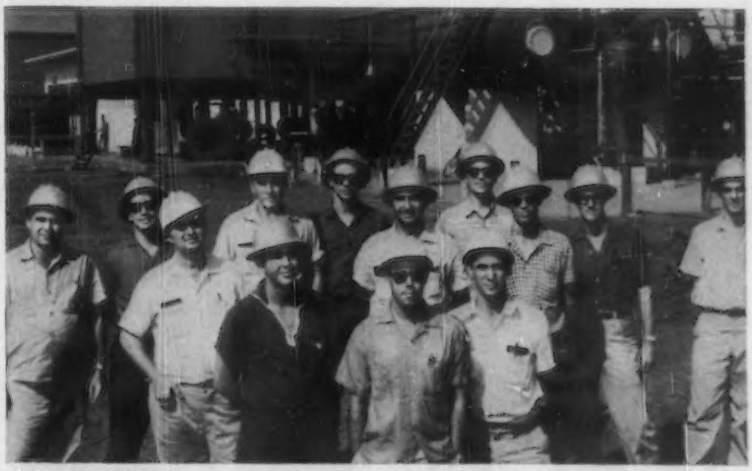


trestle (back), raw liquor thickeners, H_2SO_4 plant, the leaching section (back) and the power plant. Reservoir is in foreground.

MEN AT MOA include O. V. Ramirez, personnel manager; Bal F. Darnell, vice president and general manager; G. K. Hickin, senior chemical engineer, Freeport; J. W. Ramsey, Freeport chief engineer; Maurice F. Dufour, Freeport executive vice president; Richard V. Colligan, president of Moa Bay; Jack H. Schissler, construction superintendent; E. T. Carlson, Freeport process engineering manager; B. F. Frederick, Moa project engineer; and Hal G. Kristjanson, general superintendent of the mine department, Moa Bay Mining Co.

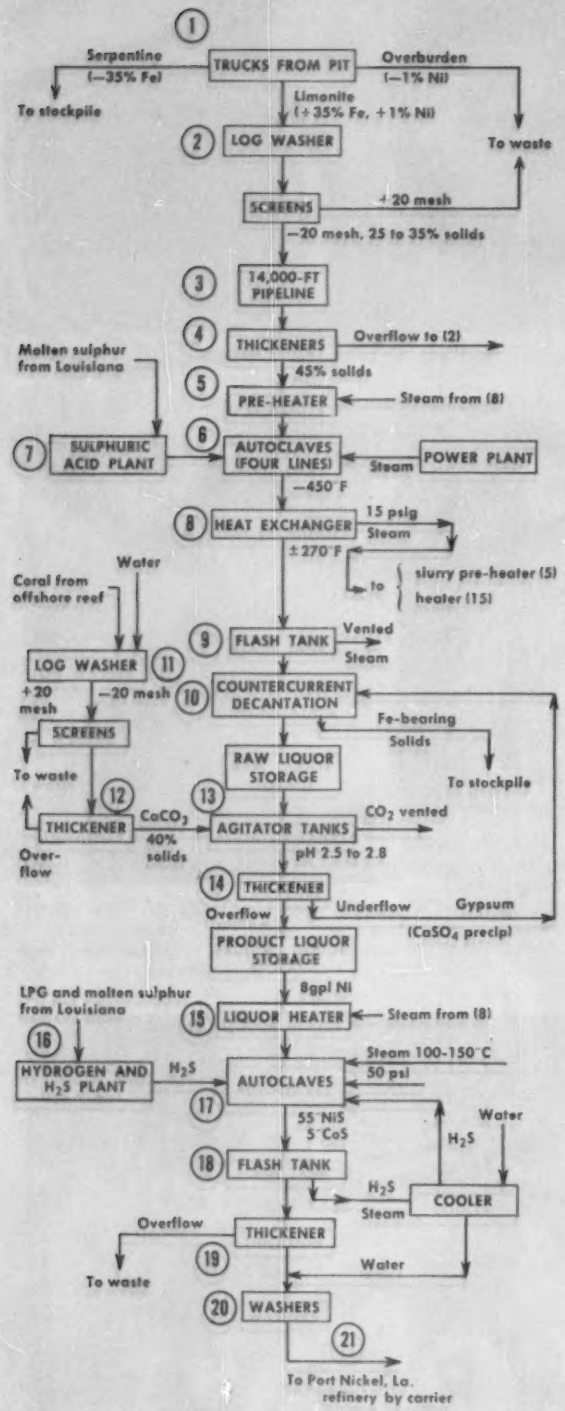
U.S. AMBASSADOR to Cuba Philip Bonsal studies the process with Les Engle, leach plant superintendent and B. F. Darnell.

The $119-million Freeport Nickel project, which will produce at a capacity of 25,000 tons of nickel, 2,200 tons of cobalt and 92,000 tons of ammonium sulphate, has been described as "one big long pipeline." One end of the pipeline is in Oriente, where Moa Bay takes the ore from the red hills, slurries it and puts it into a 14,000-ft line downhill to the $75-million concentrating plant. It stays generally in solution through the plant and down to agitated storage tanks at the Bay. It is then piped abroad specially designed tankers and carried across the Caribbean, and into the Gulf to Port Nickel, La., 10 miles south of New Orleans. The pulp is reagitated and goes to the refinery for removal of contaminants, and separation of the Ni-Co. The "pipeline" ends in a large metal-clad building where the two metals are stored in powder and briquette form, ready for market.



YOUNG CUBAN ENGINEERS, trained and employed by Moa Bay, typify the contribution which Cuba is making to the success of the project and the valuable role which the new nickel producer is taking in the growth and economy of the island.

Moa Bay Concentrate Plant—Moa Bay Mining Co.
Freeport Nickel Co.—Oriente, Cuba



LEGEND

1. Ore is mined by dragline from the iron laterite deposit. Overburden, low in cobalt and nickel, goes to waste. Limonite ore is decomposed by tropical weathering, provides working ore. Low grade, partially decomposed serpentine (minus 35% Fe) is stockpiled for possible future treatment. Eighteen 30-ton Oshkosh diesels haul the ore. Truck exhaust heats the body to reduce ore sticking.

2. Agglomerated ore is broken up in four McLanahan & Stone log washers and made into 35% slurry. Plus 20 mesh contains little nickel, goes to waste. About 90% of original ore is minus 325 mesh, screening to minus 20 eliminates about 5% of feed, including some hematite lumps, etc. Screens are by Simplicity Mfg. Co.

3. 24-in. concrete pipeline, buried on a 1½% grade, takes the ore 14,000 ft to the leaching plant at 8 fps.

4. Two 325-ft dia Dorr-Oliver raw ore thickeners take slurry down to 45- to 48% solids. Feed rate is 5,500 tpd of ore on a dry basis, which makes about 11,500 tpd of 45% slurry.

5. Slurry is pre-heated to 180°F by recovered low pressure (15 psig) steam from the slurry coolers.

6. Four parallel lines of four autoclaves in series leach the slurry. In each line, the head tower brings the solution to 450°F with contact steam. Best results have been obtained when suphuric acid is introduced after reaction temperature has been obtained. The slurry then flows by gravity through the 55-ft high, 9-ft dia reactor vessels. In general, contact time is one to two hours. Autoclaves are agitated by high pressure steam, injected below the bottoms of concentric mounted draft tubes (steam is drawn off to the preheater —No. 5). 98% H_2SO_4 is pumped into the first vessel of each line. Draft tubes, valves and couplings and interstage piping are all of titanium (see p 93). The steel vessels themselves are lined with a bonded lead lining beneath a course of acid brick and a second course of carbon brick. In the operation, iron and other metals do not go into solution, but 95% of the cobalt and nickel is extracted.

7. H_2SO_4 is produced at the plant site from molten sulphur, which is shipped from Louisiana in the same vessel which hauls NiS-CoS concentrate to the U.S. The sulphuric acid plant has a capacity of 1,300 tpd of 98% acid. 50% of high-pressure process steam is generated through the waste-heat recovery system.

8. Two heat exchangers per line of autoclaves receive the slurry and recover 15 psig steam by indirect transfer. Exchangers are of tubular titanium, 3,720 ft of it, and provide a total transfer area of 1,450 sq ft.

9. Reduction to atmospheric pressure takes place in the flash tanks through ceramic or silicon carbide chokes. Some flow is controlled by splitting the discharge stream, but the greater part (90%) flows through an open choke. Rate control is maintained on the by-pass stream where the control valve is tied with the liquid level in the fourth reactor.

10. Six-stage countercurrent decantation separates the main iron bearing solids from the solution and its nickel-cobalt-aluminum-magnesium-chromium content, the latter three minerals in minor content and iron in negligible amounts. Iron-bearing solids are stockpiled for possible future use. Six 225-ft Eimco traction-type washers are used.

11. Calcium carbonate, required to adjust the pH before precipitation, is obtained from an offshore coral reef by dredges, and recovered as a mud running 95% or more $CaCO_3$. It is washed with fresh water and screened to remove shells, trash and plus 20 material, as well as the chlorides.

12. Cleaned $CaCO_3$ is thickened to 40% solids in a 160 ft Eimco unit.

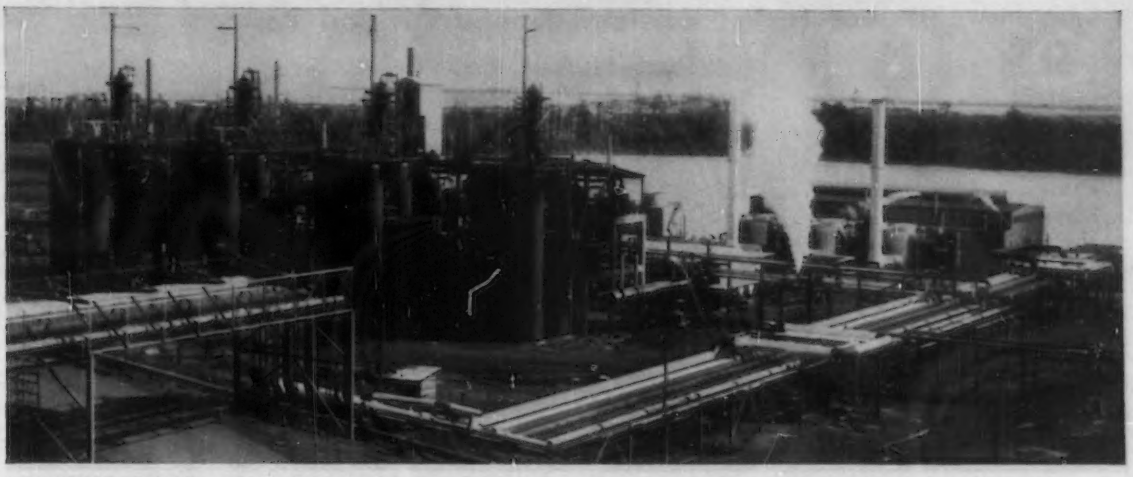
13. Agitated tanks receive the raw liquor and coral and the pH is rapidly adjusted to 2.5 to 2.8. The four tanks (in series) are wood, and use Philadelphia mixers.

14. Clarified solution from the agitators, containing about 6 gpl nickel and lesser amounts of cobalt, copper, lead and zinc is the product of two 160 ft Dorr-Oliver thickeners, which remove the gypsum and return it to the decantation system.

15. Specially designed direct contact heaters, bricklined and combining two Hestalloy-C perforated trays, preheat the solution to 245°F.

16. To supply the precipitation process, hydrogen produced at the rate of 1.5-million cubic ft per day from liquid petroleum gas (LPG) reformed with steam, is combined with sulphur to make hydrogen sulphide. The H_2S generator at Moa Bay is fed propane-butane and molten sulphur from Louisiana and can produce up to 60 tpd of H_2S. Both the hydrogen and hydrogen sulphide plants are of Girdler design.

17. Virtually all the nickel and cobalt is precipitated out in three-compartment brick-lined autoclaves, agitators from Turbo-Mixer. Pure H_2S is added from the plant. Satisfactory results require a temperature between 220°F and 260°F and a pressure of 50 psi. The H_2S is introduced below the surface and the mixture agitated. NiS is recirculated as "seed" on which the sulphides precipitate, preventing buildup on the walls and stirrers of the autoclave. A satisfactory



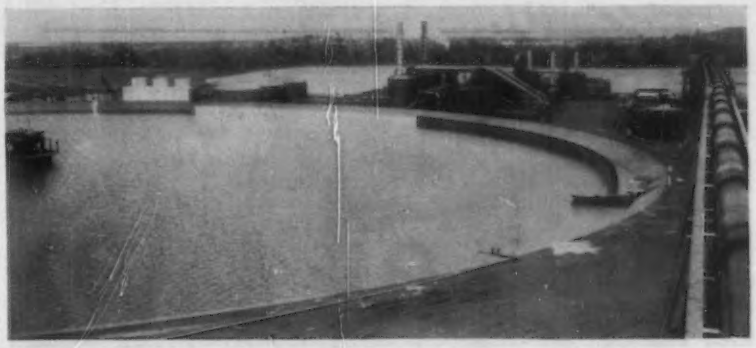
LEACHING TRAINS are 55-ft brick-lead-titanium lined autoclaves which use sulphuric acid to convert nickel and cobalt to sulphates under pressure and agitation. Slurry from mine is separated to enter one of the four separate trains.

Enter Fidel Castro

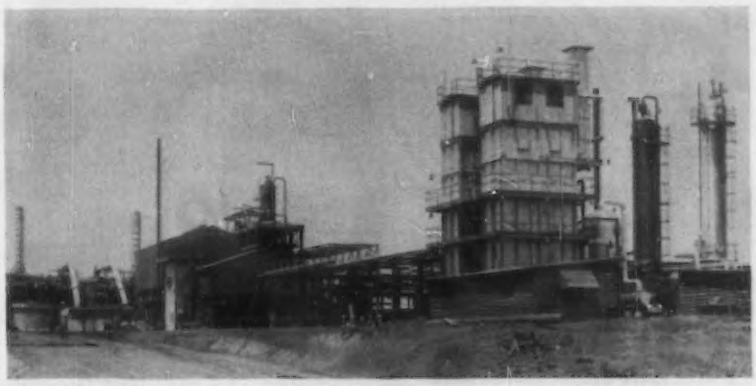
Thus, Moa Bay Mining Co. has faced and conquered the problems—of mining an ore that is a fine red dust in the dry season and an adhesive red mud in the wet; of creating a profitable operation out of a deposit which was worthless until a lengthy research program and $75-million investment brought it to life; and of placing Cuba in second rank of the nickel producers of the world.

In these, the closing weeks of 1959, the company has had to face another problem; a political one. Premier Fidel Castro, in early November, announced new taxation and mining claim fees for all mineral lands in Cuba. The governmental decree requires all mining claims to be re-registered at $100 per claim by late February 1960. A fee of $10 per hectare must be paid annually in the future for each claim under development and $20 for those lying idle. (Moa Bay holds about 30,000 hectares). Another ruling places an export tax on all concentrates leaving the island of 25% of the highest market value of the concentrates.

As this article was written, neither Moa Bay nor the other foreign producers of Cuba had been able to get an exact interpretation of the "25% of the highest market value" phrasing of the new law. Nickel observers in Canada, the first ranking nickel-producing



325-FT THICKENER receives the ore in slurry from the mine via cement-lined pipe and brings it up to 45% solids from the 25% in front of the leach train.



PRECIPITATION PLANT (left) follows neutralization and washing. Sulphides are precipitated with hydrogen sulphide obtained from the plant at right.

pH has been found to range between 2.0 and 2.5. Reaction time is a function of temperature, pressure and efficiency of agitation.

18. The slurry is flashed through chokes to atmospheric temperature similar to (9), H_2S and steam circulated to a cooler for reclamation.

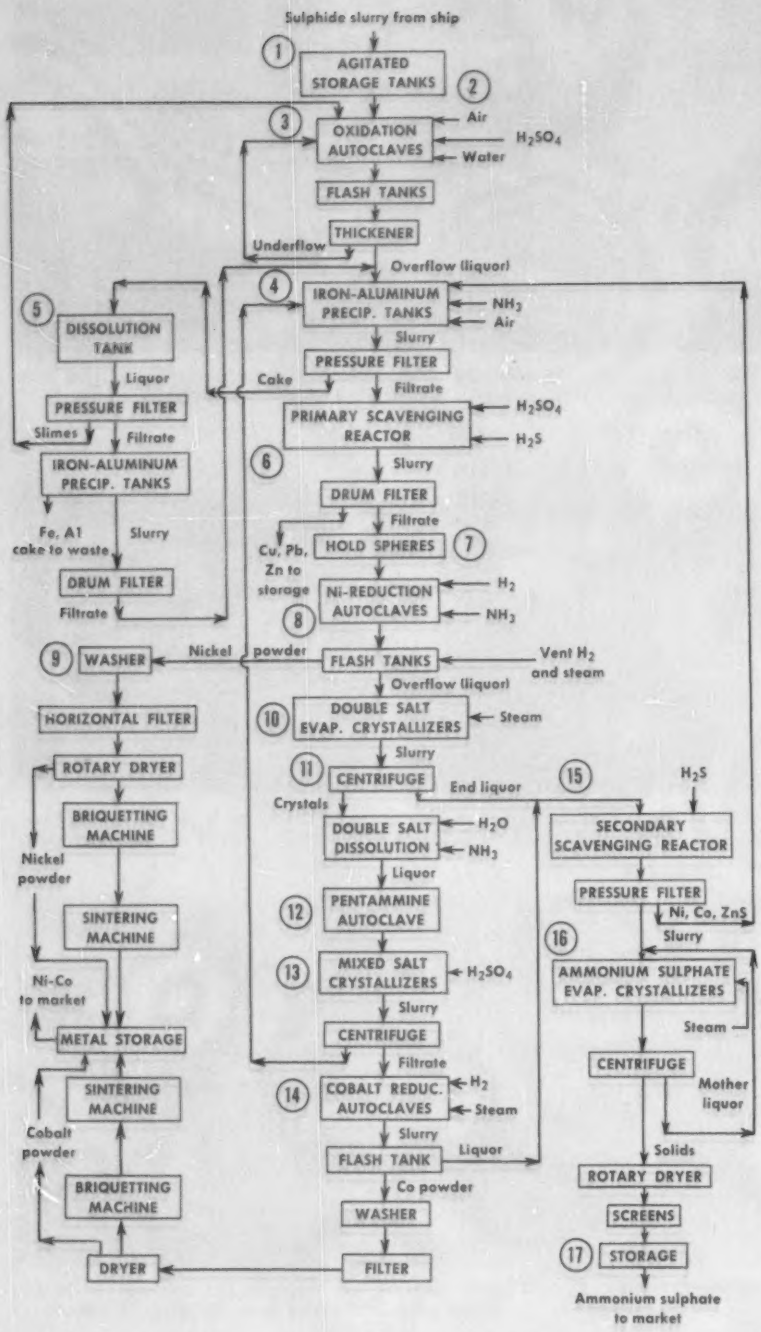
19. Precipitated sulphides are separated in two 60-ft Eimco thickeners with Hestalloy-C mechanisms and barren solution is overflowed to waste.

20. Countercurrent decantation takes place in the final washer, a 30-ft dia, Dorr-Oliver. Final product is a 65% solid in slurry, containing 55% Ni, 5% Co, and lesser sulphides of copper, zinc and iron. Freeport estimates that 93% of the nickel originally in the ore is to be found in the sulphides.

21. The ship which takes the slurry to Port Nickel, La. is a modified cargo vessel fitted with containers and compartments to bring molten sulphur and LPG from the mainland and carry a return cargo of sulphides to the refinery (see flowsheet, p 88). Sulphide storage is provided at the harbor in Moa Bay. Slurry is transferred from plant in cement-mixer trucks.

Port Nickel Refinery—Freeport Nickel Co.

Port Nickel, La.



LEGEND

1. The settled slurry in the ship's tank is resuspended at Port Nickel and a 65% solids slurry is pumped via an 1,800-ft cement-lined 3-in. pipeline to a tank farm of sixteen 20-ft dia tanks. The slurry is permitted to settle in the storage tanks and is resuspended as needed by a unique agitator specially manufactured by the Philadelphia Gear Works which can be raised and lowered in each tank and moved from tank to tank as needed.

2. The typical components of the slurry (dry weight) are as follows:

Ni	53.76%	Zn	1.25%
Co	5.28%	Cu	0.52%
Fe	0.59%	Cr	0.04%
Al	0.04%	S	35.21%

3. Oxidation of the sulphides to soluble sulphates takes place in three spherical homogeniously lead-lined steel autoclaves, each 13 ft in dia and internally lined with acid brick. On each autoclave is a Philadelphia Gear Works' agitator having a 6-in. titanium shaft and titanium impellers. Baffles and internal piping in the autoclaves are of titanium. The sulphide slurry, additional water, sulphuric acid, and air are continuously charged to the autoclaves where the sulphides oxidize in an exothermic reaction to sulphates. The slurry, after leaching, discharges through titanium letdown valves to an acid brick-lined flash tank and the overflow from the flash tank discharges to a small Dorr thickener where excess sulphide is collected and returned to the autoclave feed stream. Leached solution is controlled at 50 gpl Ni and 5 gpl Co. The spent air discharges from the autoclaves via titanium letdown valves.

4. Precipitation of the minor amounts of iron, aluminum and chromium contained in the solution takes place by adjustment of the solution's pH to 5.5 with ammonia. Air is introduced into the precipitation reactors to insure that all iron present is in the ferric state. The precipitate is filtered in a pressure filter supplied by the U.S. Filter Co.

5. The precipitate of iron, aluminum and chromium, mostly in the form of hydroxides, contains a considerable amount of nickel and also a small amount of fine sulphide slimes which overflowed the thickener. The precipitate is reprocessed by dissolution with sulphuric acid followed by pressure filtration of the sulphide slimes which return to the oxidation autoclaves. The clarified filtrate is reneutralized with ammonia to a pH of 5.0. The resultant slurry is then filtered on a string filter supplied by Komline-Sanderson Co. The precipitate is discarded as waste and the filtrate joins the overflow from the thickener.

6. The main filtrate stream from the iron-aluminum precipitation operation is treated with sulphuric acid and hydrogen sulphide in the primary scavenging pipe coil reactor to remove copper, lead and a portion of the zinc as a sulphide precipitate. This precipitate is separated from the filtrate on two large Komline-Sanderson precoat drum filters. The sulphide residue is presently regarded as a waste, but is stored for its potential value.

7. The liquor from the primary scavenging operation containing nickel and cobalt sulphates and a small amount of ammonium sulphate is heated to 375° and delivered to two elevated spherical hold tanks each 22¼-ft dia. These tanks, of 316 ELC clad steel, supply heated feed liquor to the six nickel reduction autoclaves.

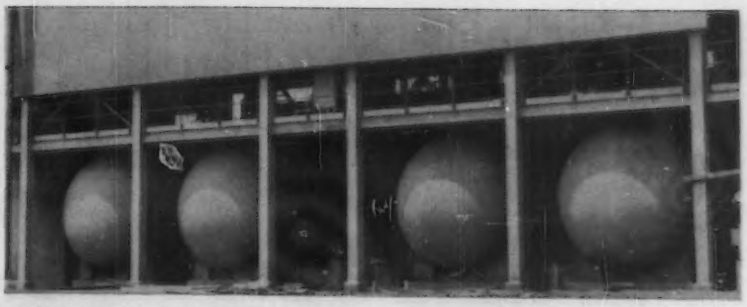
8. As required, liquor is discharged from the spherical hold tanks to the nickel reduction autoclaves where nickel is selectively recovered as a powder by reduction with hydrogen. Selective recovery of nickel is achieved by maintaining a pH of approximately 2.0 in the autoclave by controlled addition of ammonia. The six nickel reduction autoclaves are each 9-ft dia by 29 ft over-all length. They are 10% 316 ELC clad steel. Each autoclave is equipped with three 125-hp agitators supplied by Mixing Equipment Co. Reduction of nickel from solution is a batch operation and after each reduction—or densification as it is called by the operators—the nickel powder is permitted to settle in the autoclaves and the hydrogen and spent liquor are discharged to a flash tank. Upon completion of a series of densifications both the nickel powder and the spent liquor are discharged together to a flash tank.

9. Washing of the nickel powder takes place in two spiral classifiers in series which discharge to a horizontal rotary filter supplied by Filtration Engineers, Inc. The dewatered nickel powder discharges from the filter to a 5-ft dia co-current direct fired rotary dryer supplied by Standard Steel Corp. Some of the dried nickel powder is packaged in drums but the major amount is briquetted in two Komarek-Greaves bri-

nation, believe that Moa Bay cannot operate profitably if the law is enforced literally.

Freeport, in its long years of interest in Cuba, has endeavored to remain completely apart from political involvement while exerting great effort to contribute to the improvement of the Cuban people and their economy. The former was adhered to even when several Moa Bay Mining Co. engineers were held for a short time by the then-Revolutionary forces of Premier Castro in the Oriente hills. The latter has involved the steady employment of Cubans in nearly all capacities of administration and operation, awarding of scholarships for Cuban students in the U.S., an intensive training program for employees of the mine, and, of course, the construction of schools, churches and homes and hospitals for all the residents of Moa Bay.

The red ore which provides the feed



"BATCH SYSTEM" autoclaves operating between 100 and 150° at 50 psi with pure H_2S added from the plant create the reaction, using a pH of 2.0 to 2.5.

BY-PRODUCT GYPSUM is thickened in the tank in the foreground, a result of the neutralization step. Background vessels store product liquor for processing.

LAST STOP for the concentrates at the Cuban end of the "pipeline" is the set of agitated tanks alongside the "SS Sokna," specially converted tanker-carrier.

LEGEND (*Continued*)

quetting presses. The briquettes are sintered in a roller hearth—belt type furnace supplied by the Drever Co. Sintering is done at approximately 1,750°F under a reducing atmosphere. Immediately after the sintering operation the briquettes are drummed for shipment.

10. The end liquor from the nickel reduction operation is evaporated and crystallized to recover the cobalt, the residual nickel and a a small amount of zinc as a double sulphate salt with ammonium sulphate. Evaporation and crystallization take place in a quadruple effect evaporator-crystallizer supplied by the Chicago Bridge & Iron Co.

11. The crystallized slurry from the evaporator-crystallizer is centrifuged in a Bird Machine Co. continuous centrifuge. The mother liquor is delivered to the secondary scavenging section of the refinery. The double salt crystals are redissolved with water and anhydrous ammonia for further processing for cobalt recovery.

12. The redissolved double salt solution is oxidized with air under several hundred pounds pressure in the pentammine autoclave where the cobaltous ion is converted to a stable cobaltic amine complex.

13. The product liquor from the pentammine autoclave is adjusted with sulphuric acid and is then cooled in a two stage crystallizer, supplied by the Chicago Bridge & Iron Co., in which the nickel and zinc are crystallized as double salts with ammonium sulphate but in which the cobalt, bound in the stable amine ion, does not crystallize. The double salt containing nickel and zinc—called mixed salt at the refinery—is centrifuged from the cobalt containing liquor in a Bird centrifuge. The nickel-zinc crystals are returned to the front end of the process joining the overflow stream from the thickener.

14. The cobalt rich liquor from the mixed salt crystallization operation containing substantially no nickel is charged in batches to two 9-ft dia by 10½ ft over-all length 10% 316 ELC clad steel reduction autoclaves. Each autoclave is agitated by a 125-hp Mixing Equipment Co. agitator. The liquor is heated in the autoclave with steam and the cobalt is reduced to a powder by hydrogen under pressure. The cobalt precipitates in much the same manner as the nickel and is filtered, washed, treated, packaged and briquetted. The only significant difference in the preparation of the cobalt powder is in the drying where a continuous belt dryer, supplied by the Drever Co., operating at 1,000°F under a hydrogen atmosphere, is used. By this drying procedure, an extremely high grade cobalt powder containing a minimum of oxide is obtained.

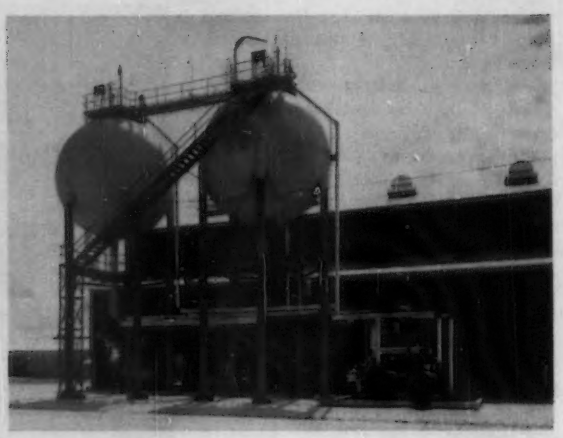
15. End liquors from the cobalt reduction operation and from the double salt crystallizer operation are combined in the secondary scavenging operations and are stripped of residual metals with hydrogen sulphide in a pipeline reactor similar to that used in the primary scavenging operation. The metal sulphides are filtered in a pressure filter supplied by the U.S. Filter Co. and are returned to the oxidation autoclaves for reprocessing.

16. The filtrate from the secondary scavenging operation is delivered to a double effect evaporator-crystallizer supplied by the Chicago Bridge & Iron Co., where ammonium sulphate crystals are recovered for marketing as a by-product. The ammonium sulphate crystals are centrifuged from the mother liquor in two Sharples C-27 Super-D-Hydrators and are dried in a 6-ft dia Standard Steel Corp. co-current direct fired dryer.

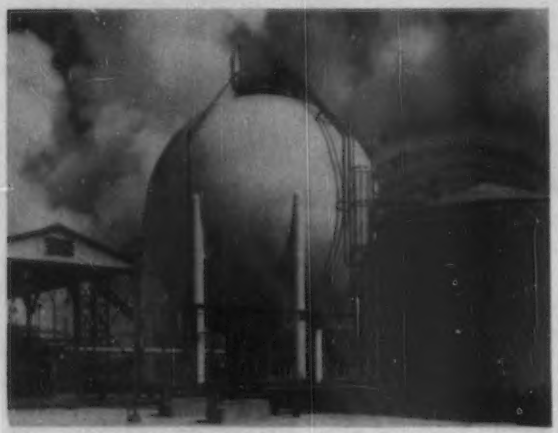
17. The ammonium sulphate—produced at the rate of approximately 270 tpd—is stored in bulk in a laminated timber arched storage building 122 x 300-ft supplied by Timber Structures, Inc. Wood construction was chosen for the ammonium sulphate storage building because of the difficult corrosion problems encountered on the Gulf Coast in storing ammonium sulphate. The plant is equipped to ship ammonium sulphate in bags or in bulk.

18. As auxiliaries to the processing operations, the Port Nickel refinery is equipped with a number of interesting utility installations. High pressure air is obtained from four 2,000-hp Ingersoll-Rand 412 KVS gas engine driven compressors which together are capable of delivering 16,000 cfm of air at 800 psig. Hydrogen, required in the nickel and cobalt reduction operations, is generated in a Chemical Construction Corp. hydrogen plant utilizing pressure reforming of natural gas at a rate of 2-million cfd. And hydrogen sulphide, used in the primary and secondary scavenging operations, is produced at the rate of 2.5 tpd from molten sulphur and hydrogen in a plant designed by the Girdler Corp. Steam is generated in three gas-fired package boilers rated at 60,000 lb/hr each at 315 psig, supplied by the Foster Wheeler Corp.

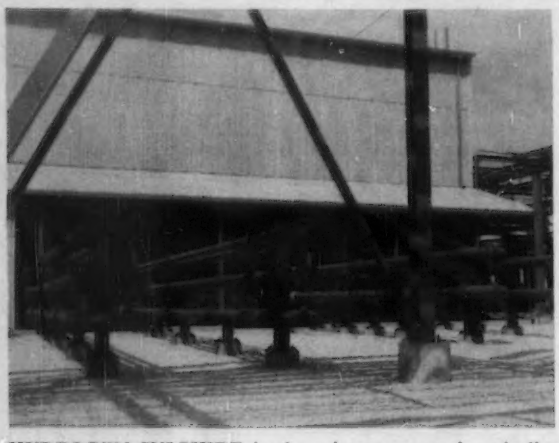
FIRST STOP at the other end of the sea voyage of the "Sonka" is agitated storage at Port Nickel, La. at the refinery.



HOLD SPHERES in front of the nickel reduction autoclaves take the filtrate following iron-aluminum removal and wash.



ANHYDROUS AMMONIA is stored in the 750-ton sphere in front of the reduction plant. Some 25,000 tons are used annually.



HYDROGEN SULPHIDE in the primary scavenging pipeline reactor removes copper, lead and zinc. They are sent to storage.

THE SULPHURIC ACID PLANT at Moa Bay has a capacity of 1,300 tpd of 98% acid. A similar facility at Port Nickel, also using molten sulphur, makes 2 tpd.

for Moa Bay's and Freeport's huge "pipeline" was first discovered in 1492 by Christopher Columbus. His log records a rowboat trip up the Moa River, with a notation that the reddish earth gave promise of valuable minerals.

The same ore today, with the technological breakthrough represented by the successful Freeport-Chemico research, is still a combination of assets and liabilities. The assets are represented by the easy mineability (90% of the desirable material is minus 20 mesh), the fortunate ratio of nickel to cobalt (separation of the metals depends upon accurate pH adjustment, using the high Ni to low Co content), and the relative absence of magnesia (Nicaro ores cannot be treated with sulphuric acid, Moa Bay's can).

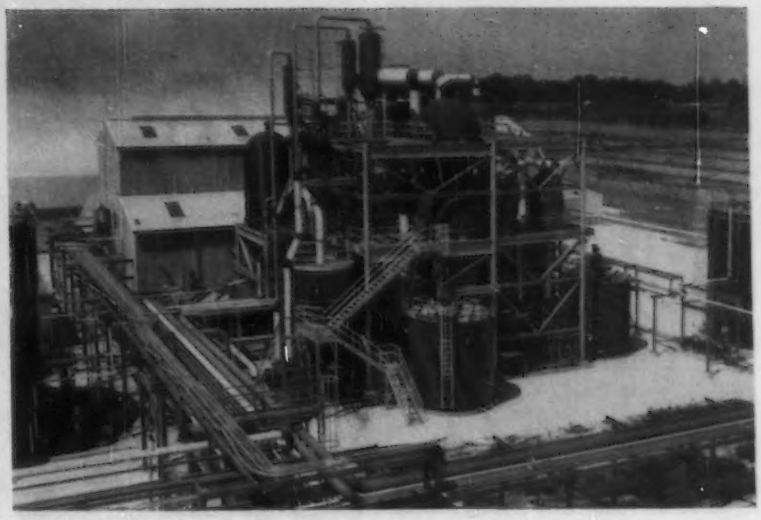
The liabilities include careful dragline operation to remove overburden, mine the payable ore beneath it, and above serpentine layer; difficulties with the sticky material in the wet season and the powdery dust in the dry; and complex problems of materials handling. The mine department alone must handle 20,000 tons of material per day to send 8,450 tons to the concentrator.

The orebodies were developed by approximately 60,000 ft of auger drill holes on 330-ft centers and proved to

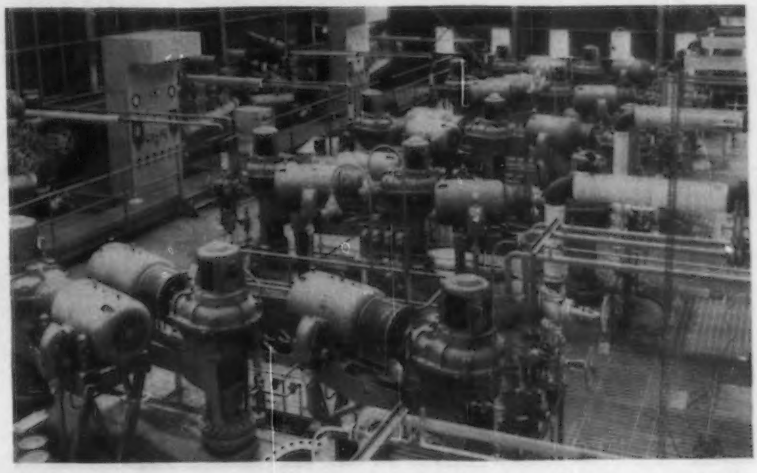
average 22 ft in thickness below an average 15 ft overburden. For mining control, Mobaco is drilling to the serpentine level on 110-ft centers and to the top of the ore on 55-ft centers. Slaked lime markers are inserted in the control holes to signal the top of the orebody to the scraper operators. The ore color change to green signals the bottom. Draglines, ranging from 2½- to 5-yd capacities and manufactured by Bucyrus-Erie and Manitowoc mine the ore. The draglines feed 18 Oshkosh 30-yd trucks, which haul to the slurrying plant in the center of the mining area. The mine works on a two-shift basis, 5½ days. After removal of the plus 20 mesh material (see flowsheet, p 86) the ore enters a proper pipeline, joined by 5,000 gpm of fresh water from the Moa River reservoir. The 25% solids slurry travels 14,000 ft at a 1.5% grade to the concentrator, with its velocity reduced by a series of concrete drop boxes, which will flatten out surges and reduce wear on the 24-in. concrete pipe.

To the Reactors

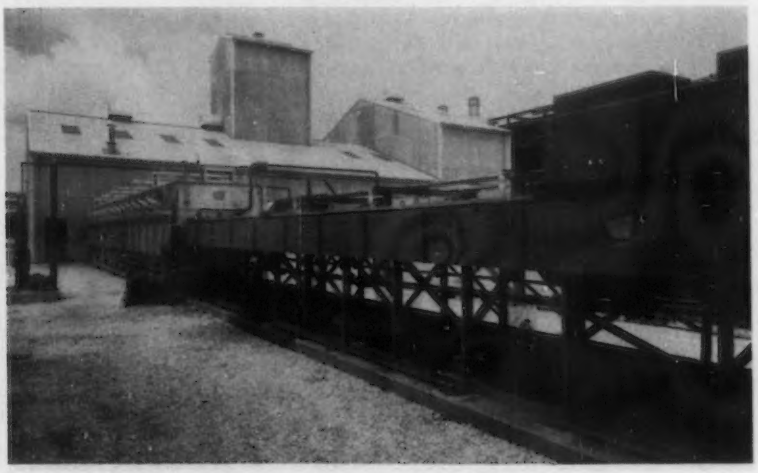
The slurry is thickened to 45% solids, water returning to the slurry plant, and then new slurry split among four leaching trains. Live steam and concentrated sulphuric acid are added to the reactors, and the slurry leached. It is then flashed into tanks at atmospheric pressure and sent to a countercurrent decantation system. Pregnant liquor is neutralized by a coral slurry, with raw material obtained from reefs just off the shore. The liquor is reacted in autoclaves with hydrogen sulphide to precipitate sulphides of nickel and cobalt, and



FOLLOWING NICKEL REDUCTION, double salt evaporation crystallizers prepare the liquor for secondary scavenging and reduction of the cobalt proportion.



MAJOR PROBLEMS in the process were agitation and corrosion. The above layout helped solve the former; titanium design by C. F. Braun & Co. the latter.



THE FINAL PRODUCTS, nickel and cobalt powder and briquettes, are sintered and stored in the metal-clad building above, ready for delivery to the market.

THIRD PRODUCT, ammonium sulphate, is sold to the agricultural field.

NEW HOMESITES FOR EMPLOYEES are terraced against the red hills of Oriente Province in Cuba, with hospitals, schools and churches provided for the people.

the concentrate shipped to Louisiana.

Engineering, design and procurement for the two primary process units at the mine was by C. F. Braun & Co., which also designed the required use of titanium in both the concentrating plant in Cuba and the refinery in Louisiana (see story, p 93).

Three special problems in the Moa Bay system, besides the need for titanium in draft tubes and interstage piping in the reaction vessels, were the high pressure pumps for the slurry system, the agitation method in the vessels and heat recovery behind the reactors.

Special pumps in front of the heater (see flowsheet) move the slurry on a normal throughput of 500 gpm at 650 psi. They are high pressure, steam turbine powered, diaphragm type. Agitation of the vessels involves introduction of steam through concentric mounted draft tubes in the tanks. Heat recovery takes place in two exchangers (for each of the four lines in the train) as 15 psig steam via indirect transfer.

Two major auxiliary installations are included in the Moa Bay concentrator, and contribute to the process: the sulphuric acid plant and the hydrogen-hydrogen sulphide plants. They are described in the legend for the flowsheet on p 86.

Accessability of raw materials was the final determining factor in the division of the mine plant and the refinery. Preparation of the final product from the sulphide slurry requires volumes of ammonia and hydrogen, with cheap natural gas necessary both for the process hydrogen and the hydrogen used in NH_3 synthesis. Gas is available in Louisiana, and so dictated the refinery location.

The "pipeline" from Oriente takes two new forms as the slurry leaves the reactors and filters in the concentrator. Cement mix trucks provide transportation from the plant to the agitated storage tanks at dockside, from which the 65% solids are transferred aboard the *SS Sokna*, certainly the unique section of the materials handling scheme. The vessel is a converted Liberty ship which acts as a tanker for concentrates and chemicals as it shuttles from Moa Bay to Port Nickel. On the northbound run it accommodates, in eight rubber-lined tanks, approximately 2,800 tons of nickel-cobalt sulphide slurry. The tanks are 18 ft dia by 18 ft deep, arranged in two groups of four tanks each. The slurry will be allowed to settle during the voyage and reagitated as the destination is sighted, to be pumped ashore to surge storage at Port Nickel.

On the southbound voyage, the carrier takes about 5,800 tons of molten sulphur aboard in insulated tanks as well as approximately 140 tons of liquid petroleum gas in cylindrical deck tanks. Round trip takes about 12 days.

—And to the Refinery

Processing of the Cuban sulphide slurry involves consumption at the Port Nickel facilities of 1.5-billion cu ft of natural gas, for hydrogen gas production in the process and for boiler feed. Metal recovery requires some 25,000 tons of ammonia, and 17,000 tons of sulphuric acid.

The basic steps of the Port Nickel process (see second flowsheet, p 88) are as follows:

1. Conversion of the nickel-cobalt sulphide to soluble metal sulphates by oxidation at high temperature and pressure.
2. Purification of the sulphates.
3. Precipitation of a low-cobalt nickel powder with hydrogen in the presence of ammonia.
4. Crystallization to remove the remaining nickel content for recycling.
5. Precipitation of low-nickel cobalt powder with hydrogen in presence of ammonia.
6. Recovery of ammonium sulphate (fertilizer) by crystallization and evaporation.

The entire Port Nickel layout, based on fundamental data provided by Freeport, was a C. F. Braun "turnkey" operation, and once again, titanium found important application in the primary reactor steps.

Auxiliary plants at Port Nickel compare with the Moa Bay flowsheet, the major components including a compressor plant of four machines of 2,000 hp each with a capacity of 5,700 cfm of air at 800 psi; a power plant with a 60,000 pounds of steam per hour capacity, 417°F at 285 psi. The boiler is fed by natural gas.

The H_2S plant in Louisiana is similar to Moa Bay's but with a capacity of only 2 tpd.

The final products of the "pipeline" are nickel, cobalt and ammonium sulphate. Both the nickel and cobalt are warehoused in powder and briquette form for sale to the market. Briquettes, which form the bulk of sales, are first sintered on the way to storage. Ammonium sulphate is a by-product of the process, separated from the system after the nickel and cobalt have been removed, and sold as fertilizer to the agricultural industry.

Bibliography

Information on the Freeport Nickel Co. mine, plant and refinery used in this article was gained from interviews with Freeport personnel and from the following sources:

E&MJ, September 1957, p 78

E&MJ, May 1953, p 132

E&MJ, July 1953, p 148

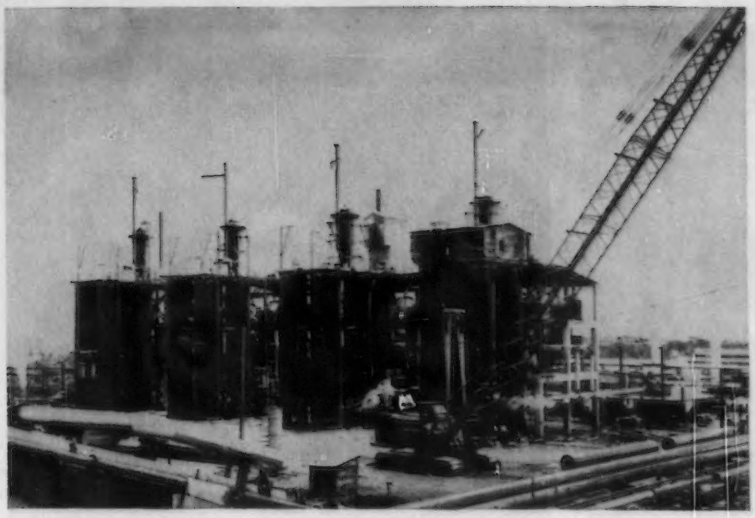
E&MJ, March 1952, p 88

"New Nickel Process On Stream," CHEMICAL ENGINEERING, Sept. 7, 1959 pp 145-152.

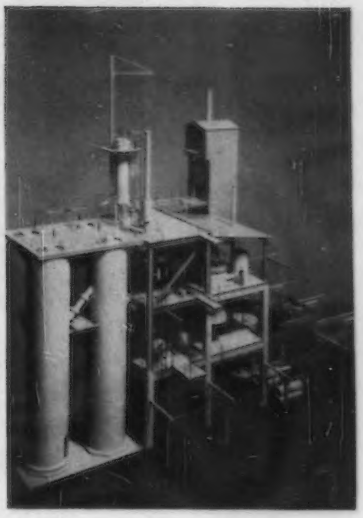
"A New Chapter in Cuba's Mining History," Freeport Nickel Co. 1959

"The Moa Bay-Port Nickel Project, New Free World Source of Nickel and Cobalt from Cuban Ores," by Forbes Wilson, vice president, Freeport Sulphur Co., AIME reprint, annual meeting, New York, February 1958.

E&MJ is also indebted to J. Albert Curran, of C. F. Braun & Co., Alhambra, Calif. for information used in preparing the article.



ECONOMICAL USE of titanium for piping and process vessels was vital when dealing with such a high cost material.



Before the four leaching trains at Moa Bay (left) were built, Braun engineers built and studied a 1:50 scale model.

Titanium's Breakthrough at Freeport

J. ALBERT CURRAN

TITANIUM has made a major entry into the processing industries. The Freeport Nickel Moa Bay and Port Nickel projects mark the first large-scale use of titanium in an industrial plant. Pilot-plant operations gave titanium first place among the metals tested in a severe corrosive service, and justified the use of that high-priced metal.

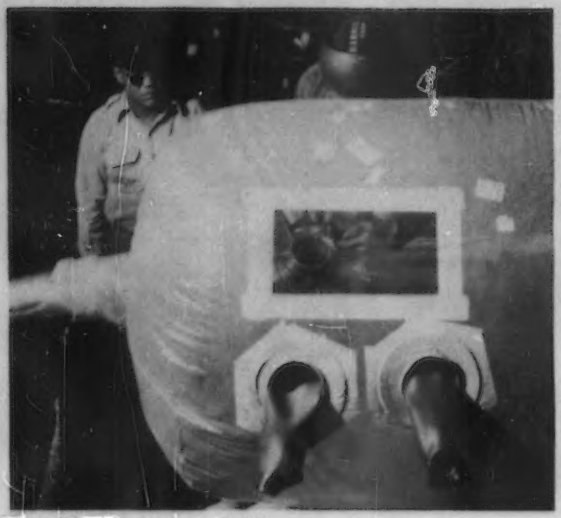
This may be the beginning of a comeback for titanium, which has depended almost completely on the aircraft industry. About 90 to 95% of the titanium produced has gone into aircraft engines and structures, where it is used because of its lightness with strength. Changes in military needs have caused violent fluctuations in demand and production. Sponge production rocketed from 2,500 tons in 1953 to 17,000 tons in 1957, then plunged to 4,500 tons in 1958. Titanium producers hope that the Freeport project is the start of increasing demand for the metal in industries other than aircraft.

The $119-million nickel-cobalt project, with complementing facilities at Moa Bay, Oriente Province, Cuba, and Port Nickel, La. involves a relatively complex sulphuric acid beneficiation at the Cuban minesite, shipment of concentrated sulphides by tanker to Louisiana, and recovery of the metals by evaporation, acidification, crystallization and reduction with hydrogen.

The two principal parts of the plants subject to corrosion are the leaching reactors and associated piping at Moa Bay, and the oxidation autoclaves with their piping at Port Nickel. The Moa Bay plant has sixteen 55-ft-high leaching reactors that process a total of 2.3-million gal of mixed ore and acid daily. Leaching takes place at elevated temperature and pressure. Four reactors in series for each train have a total retention

PACKING AND TRANSPORTATION went so far as to move the pipe by tractor-trailer to Caribbean port, lift the truck aboard the ship and move whole job to Cuba.

Mr. Curran is senior engineer at C. F. Braun & Co., of Alhambra, Calif., which was responsible for engineering, design and procurement of the primary processing units at Moa Bay and for engineering, design, procurement and construction of the refinery in Louisiana. Photos are courtesy of C. F. Braun and the Crane Co.



CAREFUL WELDING of nozzles and branch connections was done by Crane Co. in canopies filled with argon and sealed.

"TEMPERAMENTAL Ti" required inert gas from a trailing shield and interior jig for welding, as well as a lot of patience.

time of about two hours. Sulphuric acid concentration is about 10%. The autoclaves at Port Nickel are subjected to dilute acid at high temperature and pressure.

These areas were recognized as the chief corrosion trouble points. Plant onstream time would be determined by corrosion resistance.

Freeport Nickel ran a pilot plant for 15 months, during which time many construction materials were tested. Tests on the materials and the process ended in December 1956. In the critical corrosion areas described above, Freeport tested stainless steels, Hastalloys, Carpenter 20, Monel, Illium G, 17-4 PH, Haveg, a number of non-metallics, and titanium. Titanium, with a showing of negligible corrosion, won the undisputed first place.

The pilot-plant tests resulted in the following design for the critical equipment. The sixteen 55-ft-high reactors were lead-lined and shipped from C. F. Braun & Co. shops to Moa Bay, where they were brick-lined in the field. The overflow pipes between reactors were lined with homogeneous lead, then with brick, and finally with titanium. The reactor draft tubes and the nozzle inserts were made of titanium. The pipe lines connecting the reactors, slurry heaters, slurry coolers, and flash tanks were titanium.

At Port Nickel, the oxidation autoclaves are lead-lined and brick-lined. The agitator shafts and blades, autoclave nozzles, and connecting piping, up to and including the let-down valves, are titanium.

The transition from pilot plant to final installation involved problems of engineering, design, procurement, fabrication, and installation. The solution of the problems brought with it a contribution to the technology of metals.

Having determined that titanium met the corrosion and strength requirements, Freeport gave Braun two assignments. (1) Minimize the amount of titanium consistent with the requirements for usage. (2) Tackle and solve all problems connected with the use of titanium, from engineering to final installation.

The first assignment was one of engineering, design, and economics. To reduce the volume use of high-cost titanium, engineers made exact calculation of thicknesses instead of using standard thicknesses. Design of the titanium items had to be complete before orders were placed. Piping had to be completely laid out so that purchase orders could be for exact lengths. The importance of economizing on the amount of the expensive metal may be judged by the price tag for the fabricated titanium. The total cost was some $800,000, of which 85% was for the Moa Bay plant.

The greatest use of titanium for the project was in the piping. For maximum economy, it was worthwhile to study individually the design factors that determined the quantity of titanium. The factors studied were pipe diameter, pipe thickness, and layout. The piping sizes set the size of valves and of nozzle inserts in the vessels.

The basic principle for pipe sizing was to use the minimum size for maximum permissible velocities. Based on pilot-plant experience, Freeport specified the maximum velocities in the slurry lines. They also specified the use of bends instead of ells for the erosive service of hot slurries. Braun then computed the principal line sizes as 5 and 8 in. for the Moa Bay design, and 3 and 4 in. for the Port Nickel design.

Freeport and Braun engineers agreed on the following steps for determining thickness. For welded pipes, minimum thickness was calculated and 15% was added to take care of thinning of wall sections in bends, and for other unknowns. For seamless piping, 12½% was added to the calculated wall to allow for mill tolerance.

A comparison of the computed thicknesses versus standard-pipe thicknesses revealed a difference of 10% on the average in favor of the computed pipe. Ten percent meant a substantial saving in the high-cost material. Schedule 40 titanium pipe with standard wall thickness cost about $200 per ft for 5-in. pipe and $275 per ft for 8-in. pipe. Savings by use of the lighter-wall pipe amounted to $20 to $27 per ft for about 1700 ft.

A number of factors influenced the layout of the piping. These included locations of equipment, flow characteristics of the slurries, problems connected with fabrication, and mechanical-stress calculations. Braun engineers used two effective tools for this phase of the work, a 1:50 scale model of a leaching train, and an electronic digital computer. The model permitted a graphic view of a number of different arrangements of equipment at much less expense than with the preparation of the same number of layout drawings.

The electronic digital computer

was used to assist in making precise calculations of flexibility and stress. A designer unfamiliar with the use of titanium might think the piping design is too rigid. The secret lies in the low modulus of elasticity of titanium, 15.5×10^{-6} psi, compared to steel's 30×10^{-6} psi. This gives the titanium greater flexibility and permits close-coupled runs.

The design engineers studied the economics of each layout. For example, they compared the cost of forming pipes from long plates with the extra mill expense and low cost of fabrication and erection, versus shorter plates with high fabrication and erection costs, but low mill costs. Detailed layouts were influenced by special pipe-fabrication techniques for titanium. For example, such things as seam orientation and locations of welds are more critical in the design of titanium piping than with other metals.

Braun metallurgists and purchasers carried out the second assignment concurrently with the engineering and design assignment described above. This assignment was to establish adequate and practicable specifications for the production of pipes from plates and the fabrication of titanium pipespools. It included the evaluation and selection of producers and fabricators on the basis of experience and capability. Specifications had to be practical and acceptable to producers and to fabricators.

Steps in the program involved establishment of physical and chemical properties of titanium plate, welding procedures, welder qualifications, pipe-bending procedures, and test methods. This, too, was pioneering since previous specifications and procedures had been developed only for small parts in aircraft. This was the first venture into the use of large size titanium piping.

Braun's purchasing department sent preliminary inquiries to mill producers of sheet and plate, manufacturers of pipe, fabricators of pipe, and manufacturers of valves and fittings. The answers to these inquiries formed the basis for narrowing the field of qualified suppliers. The next step was a tour of investigation.

Before visiting the producers and the fabricators, the senior research metallurgist assigned to the investigation consulted several research agencies and other engineers who had experience with titanium. These included Battelle Memorial Institute, where welding techniques were being studied; Du Pont, one of the leaders in the titanium production, and the California Institute of Technology. He visited the most promising candidates for production and fabrication of piping.

The firms judged as best qualified of those visited were invited to submit proposals. After final selection was made, Braun's metallurgists and inspectors worked closely with the successful firms in solving a number of production problems. Some of the problems are described below. The findings and the results of the combined efforts in solving production problems were fed back to the industry as practical revisions to specifications and standards.

The mill rollings for the plates were special—the thickest titanium plates produced up to that time. ASTM Specification B-265-52T, Grade 2, was the starting point for the material specification. All mills consulted felt that the ASTM specification was not up to date. For example, the mills maintained the tungsten percentage lower than the specification. Iron limits differed at different mills. Finally, the mills and the metallurgist agreed on practical physical and chemical properties. Most of the plate was supplied by Republic Steel.

Setting the Standards

Prior to the Freeport project, no standards for quality of pipe-production had been established, since only a very small quantity of large diameter titanium pipe had ever been produced. The Nooter Corp. of St. Louis produced the welded pipe. The 5-in. and 8-in. sizes were fabricated from rolled-and-welded plate. Titanium Metals Corporation of America fabricated the seamless pipe.

The temperature range for forming was maintained between 600° F minimum and 1,000° F maximum. The welding jig had to provide complete inert gas coverage inside and outside of the pipe. The welding procedure was inert-gas metal arc, with filler-wire automatically added. No special treatment was required at that time because later the pipe-fabricator would stress-relieve.

Inspection was rigid. Close tolerances were required on diameter and roundness to minimize the problems of the pipe fabricator in butt welding. Welds were 100% X-rayed and tested for hardness and tightness. Finally, dye penetrants were used to search out surface flaws.

Crane Co. received the pipe from Nooter for the third phase of the production work. The only previous successful bending of large titanium pipe had occurred several months earlier in the shops of Pittsburgh Piping, witnessed by Braun's metallurgist. More was learned about bending as work progressed in Crane's shops.

Bending shoes could not be used. The pipe had to be preheated to not more than 1,000° F prior to bending, with minimum temperature 600° F during bending. Crane placed the pipe to be bent in sand beds inside larger-diameter carbon steel pipe to avoid flame-impingement on the titanium. Temperature controllers maintained the prescribed limits of temperature.

All fittings were cast and machined by Oregon Metallurgical Corp. Differences in thickness tolerances and ovality between the rolled plate and the fittings brought problems of attachment. Special jigs had to be used to round out the pipe for attaching to the fittings. Porosity, cracks from incomplete shielding, and similar headaches slowed the early phases of fabrication until the fabricator's procedures and welders eventually tamed the temperamental metal.

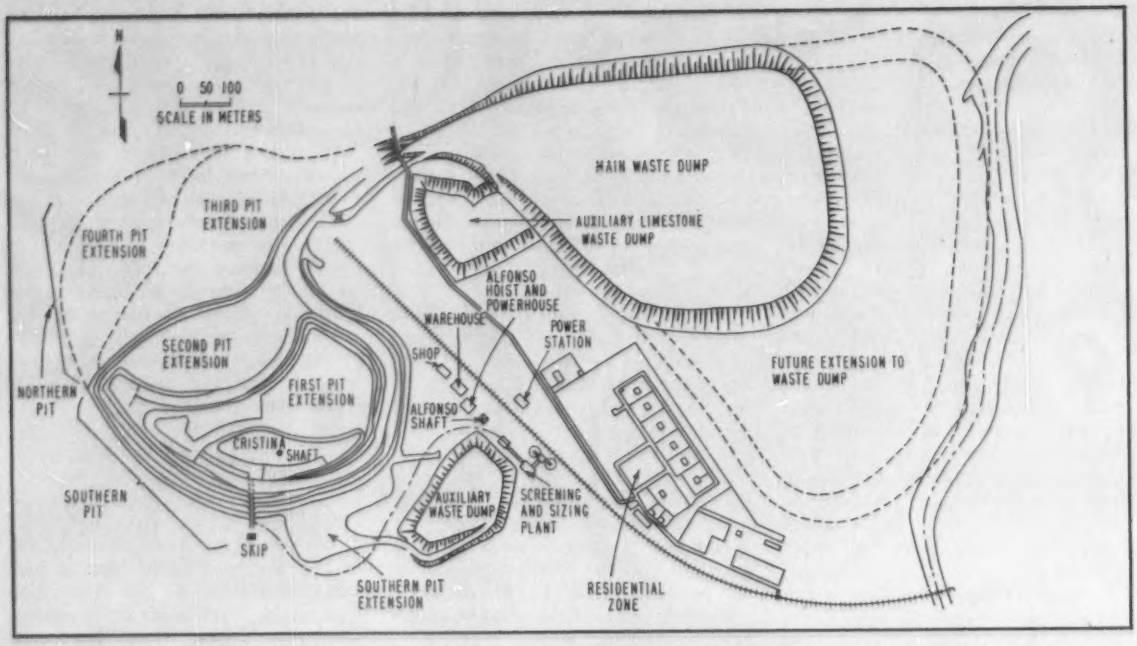
Crane used the open-air method for welding, with trailing shield and an interior jig for inert-gas shield, on all but the welding of nozzles and such connections to the pipe. For these, welds were made in a canopy filled with argon. Braun inspectors used an exposed filament of a light bulb as a constant check on the inert atmosphere.

Valve castings marked another area of pioneering. The castings for the 5-in. and 8-in. valves were larger than any previously made of titanium. ASTM Class 2 X-ray quality was specified for all castings and weld repairs. There were a number of lost castings because of porosity and cracks until the methods were settled down.

All the techniques learned in the shops had to go to the field with the fabricated products. Detailed field work-specifications and welding procedures were written. The senior research metallurgist went to Cuba and Port Nickel to make sure that the procedures and methods were understood. His mission was complete only when a sufficient number of welders were qualified, and when they had demonstrated their performance.

Titanium has made its debut in the processing industry. Many of the basic production problems connected with the metal have been solved. A nucleus of companies has acquired the technological knowhow of fabrication. Freeport's project was the testing ground. The benefits are now available to others in the processing industry.

The author wishes to thank Freeport Nickel for permission to publish this article. The author prepared the article with assistance from Thomas H. Anderson, project manager for C. F. Braun & Co. on the Freeport project, and G. Robert Prescott, senior metallurgical engineer, who coordinated the titanium work for the project.



WHEN FULLY DEVELOPED, Marquesado's oval pit will be 800 m long and 500 m wide. Approximately 21,290,000 cu m of alluvium will ultimately be removed from the pit, together with about 2,840,000 cu m limestone waste.

Marquesado—Spain's Largest Iron Mine

JOHN B. HUTTL

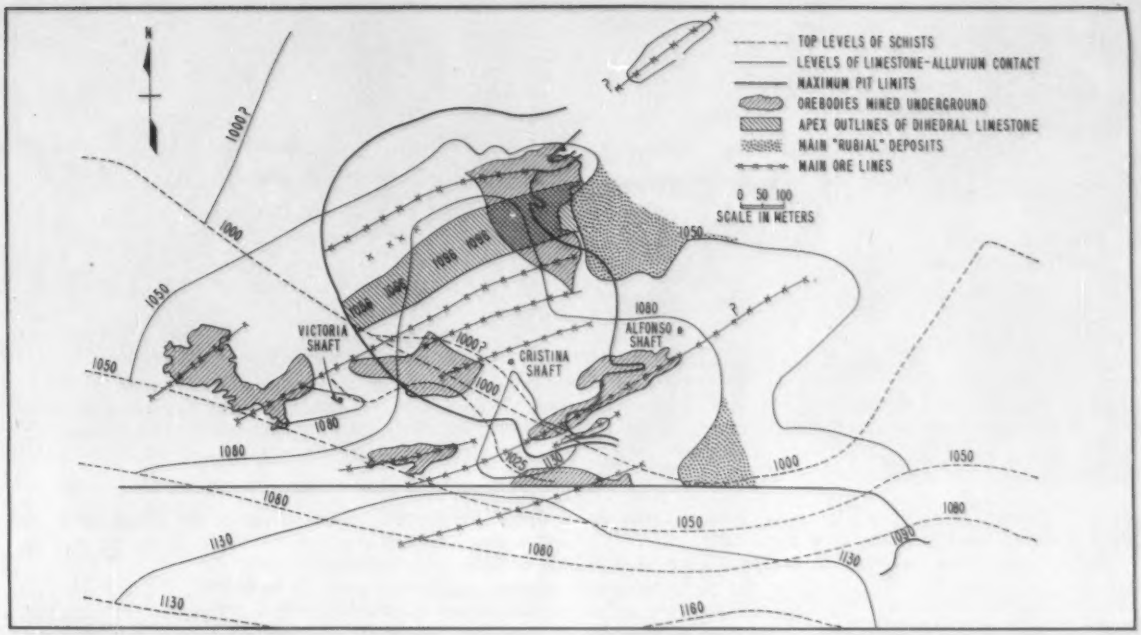
SPAIN'S LARGEST PRODUCER of high-grade iron ore in 1959 is the Minas del Marquesado property operated, since 1929, by Compania Andaluza de Minas S. A. in the Province of Granada. The mine is on the north flank of the Sierra Nevada at the edge of a vast alluvial plain, the Marquesado del Cenete, at an altitude of 1150 m. Guadix, the center of a prosperous agricultural region and the nearest large settlement, is 22 km away. Granada, the province capital, is 81 km from the operation. Mine output is transported to the port of Almeria over a 96-km branch-line.

MARQUESADO'S TOP MANAGEMENT includes: Michel Lecarpenter (left), mine superintendent; Georges Roziere, resident manager, and R. P. de Ceccatty, assessor general.

The agricultural land surrounding the mine is divided into small farms, providing a modest livelihood for the inhabitants of the region. Most of the labor employed in the mines come from the small villages lying within a radius of 13 km from the Marquesado holdings visited by E&MJ in May 1959 to obtain a detailed description of the iron deposits and operations carried on today at the pit and underground.

The iron ore deposits of the Marquesado region are divided into two separate concessions. Compania Andaluza owns and operates the northern part, where the ore is completely covered by a thick layer of alluvium, and Minas Alquife the southern section in which the deposit outcrops along a low hill. The first operator in the area was the Bairds Mining Co., Ltd. It was active from 1900 to 1929 doing comprehensive exploration and development work to determine the extent of the deposits. Three shafts were established and lateral work was carried out on three levels, the 1046, 1076, and 1096, all below the permanent water level. Total length of the lateral workings amounted to some 30 km.

In 1929 the Bairds' holdings were acquired by Compania Andaluza de Minas S. A., which began putting the property on a production basis. A thorough examination of the mine was undertaken to determine the best and most economical method to exploit blocked out and known ore-deposits, the decision falling on a combination open pit-underground operation. Current ore reserves are estimated at 12-million tons above the permanent water level



ENTIRE OREBODY is covered by 100-m Piedmont gravel formed by severe Oligocene erosion. Hematite (54% Fe) occurs as a substitute deposit in the domed Triassic limestone and, because it's porous, the ore makes an ideal blast furnace feed.

and at least 10-million tons below the permanent water level. More than 3½-million tons of ore have been mined so far. Except for periodic interruptions during the Spanish civil war and WWII, the mine has operated continuously since it was taken over from Bairds Mining in 1929.

Local Geology Presents Water Problem

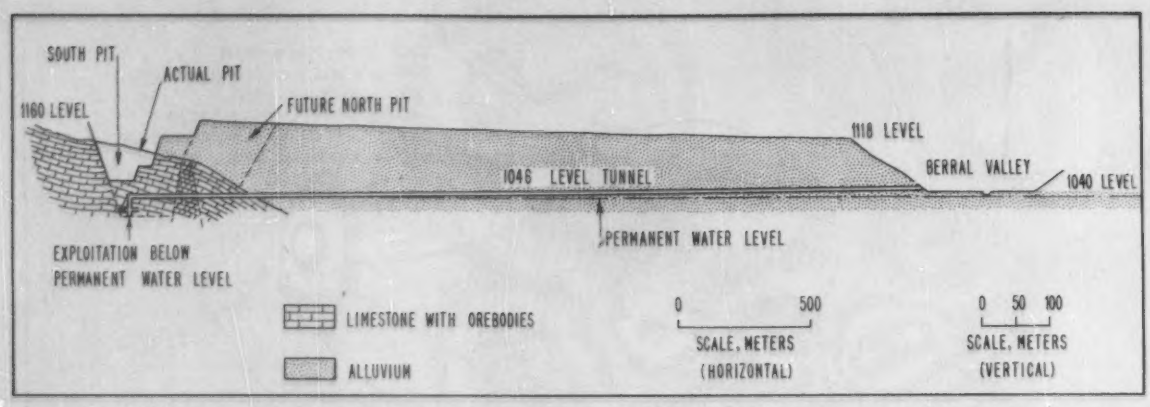
The orebodies mined at Minas del Marquesado occur in limestone domes, covered by Piedmont gravel about 100 m thick. This material is the result of erosion of the nearby Sierra Nevada during Oligocene times. It consists of that boulders of mica schist and of fine abrasions of the same schist. The limestone domes proper rest on layers of shales and mica schist. Flat beds on impervious shale present in them played an important part in giving the orebodies the shape of mushrooms. The ascending mineral solutions were forced by the beds to spread horizontally at openings or points of weakness, forming mushroom-shaped mineralized areas in the process. The hematite averaging 54% iron is the result of substitution of the Triassic limestone by mineralizing agents. Because of its porous nature, the ore makes an ideal blast furnace feed. Chemical composition of the mine-run ore is as follows: Iron, 54.5%; manganese, 1.73%; sulphur, 0.022%; phosphorus, 0.017%; alumina, 1.10%; lime, 5.75%; magnesium, 0.68%; and silica, 3.88%. Moisture content averages 10%.

The permanent water level is at an altitude of 1041 m or about 120 m below the surface level. Because an underground lake has been formed, exploitation of orebodies lying below the water level presents a serious and costly pumping problem. Several plans are now being studied, among them gravity drainage via a 7-km tunnel established below the water level, and driving a drainage tunnel just above the water level and pumping the water into it. If done, this would shorten the length of the required tunnel by 3 km and reduce the present pump head of 140 m to 46 m. Another scheme would be to mine material lying between the 1000- and 1046-m levels by quarry methods, using draglines. Owing to disadvantage such as dilution of ore, drying of ore after mining, low production, etc., this method is considered a last resort. It is the second plan which ultimately will be adopted.

Pit Resembles Pima's Operation

The large pit in operation today is oval in shape and, in size and depth, resembles the Pima pit near Tucson, Ariz. It is laid out for spiral entrance and, as at Pima, is served by an incline skip installation. When mining limits are reached, the pit will measure 800 m along the long axis and 500 m along the short axis. Oreshoots outside the economic boundaries of the pit are exploited by underground methods exclusively. Approximately 21,290,000 cubic meters of alluvium will ultimately be removed from the pit, together with about 2,840,000 cu m limestone waste material, and 10,800,000 cu m ore. The average amount of waste per ton of ore mined is 1.3 cu m alluvium and 0.20 cu m limestone waste.

Overburden is mined by shovels—no blasting is required. This is not the case with the limestone waste below the alluvium, which must be drilled and blasted. Exposed ore sections are mined by typical open pit methods, the bench heights being determined by the shape and extent of the orebody. In general, they vary from 10 to 12 m. Shovel equipment used for stripping overburden consists of 2½-yd B-E electric shovels, with work proceeding from three levels or stations. Daily output per shovel is 2400 cu m. The limestone waste material is drilled with a Joy T-500 Challenger drill, using bits with tungsten-carbide inserts. This equipment is also used in drilling ore sections. The 100-m holes are drilled to a depth of 12 m, and a blast of eight holes usually will break 1,000 cu m of ore or limestone waste. Blastholes are spaced at 4-m centers and 3.5 m from the toe of the bench. Two medium-weight Joy wagon drills using 1½-in. round-steel drills are available for drilling horizontal or toe holes when needed. Secondary blasting is done with jackhammers and drills made from ⅞-in. hexagonal steel. Blasting is done with Trinolite No. 1 (76% ammonium nitrate and 14% nitroglycerin). The cartridges used in the 100-mm blastholes are 90 mm in dia and 400-mm long. About 35 kg of powder are used



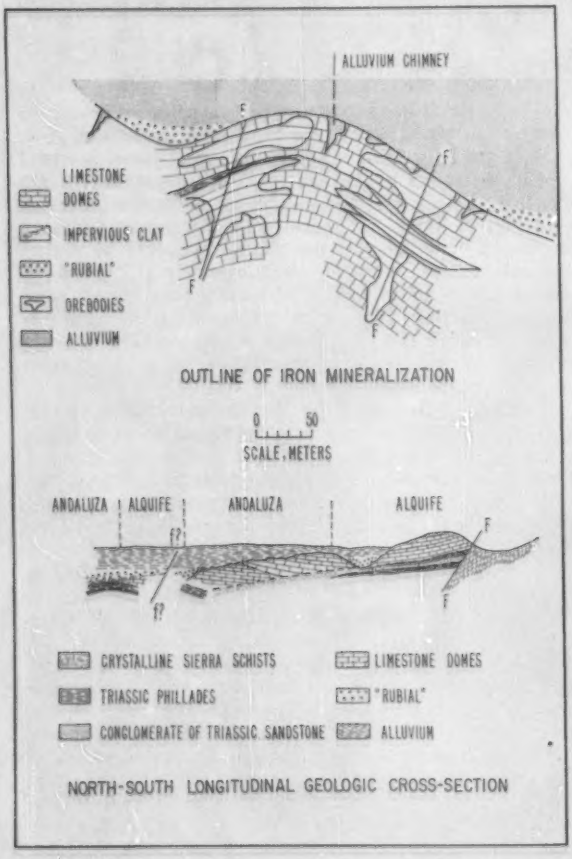
AMONG PLANS being studied by the Marquesado management to solve the mine's water problem is gravity drainage via a 7-km tunnel below the water level, and driving a drainage tunnel just above water level and pumping the water into it.

per hole. Powder consumption per cubic meter blasted is 300 g. Loaded holes are detonated electrically.

Loading operations follow U.S. practice, each shovel being served by two trucks. Of interest is the switchback waste haulage system employing 25-ton remotely controlled Woodford side-dump cars. The control equipment is located in towers, with one man directing spotting and haulage of empty and loaded cars. The system operates at a maximum grade of 6% and serves the limestone waste areas. Ten cars are available for work in the pit and on the surface.

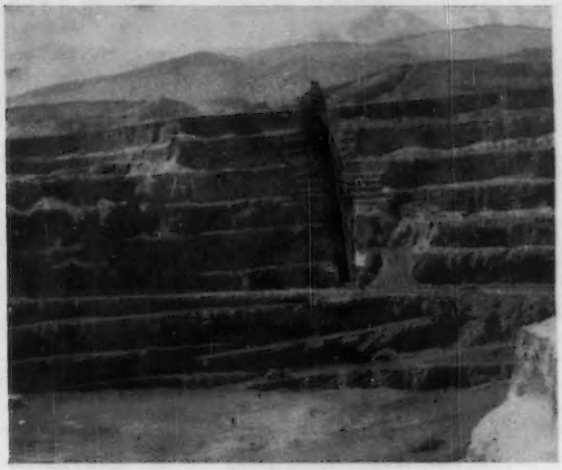
Shovel equipment used in the pit for loading ore and waste consists of two 2½-yd B-E 75 electric shovels; two 2½-yd R-B 54 electric shovels; two 1½-yd R-B 38 diesel shovels; and two R-B diesel shovels for exclusive use at waste dumps and stockpiles. The 2½-yd units handle overburden and water and the 1½-yd machines, ores. A total of more than 10-million tons of material has been handled by the two B-E 75 units since their purchase in 1930, and both are still performing satisfactorily. Marquesado also reports that one 110 R-B electric shovel will be received and put into operation at the end of 1959.

All haulage below the 1107 level (the deepest served by the Woodford switchback haulage system) is done with 15-ton Euclid rear-dump trucks. Depending on the type of material handled, ore or waste, these operate between shovel loading points and pocket at foot of incline skip hoisting system, Woodford car loading points, and loading bins at the top of skip hoisting system and waste dumps. Maximum haulage distance to waste dumps is 2 km. Ore hoisted to the surface is transported to the screening and sizing plant near the pit entrance in the 25-ton Woodford



MUSHROOM-SHAPED ore zones were formed when rising solutions spread horizontally along the impervious shale layers at openings or at points of weakness.

REMOTE-CONTROLLED SWITCHBACK rail system with 25-ton side-dump cars removes domed limestone waste.



SKIP HOISTING SYSTEM, similar to the one at Pima, Ariz., has a total track length of 90 m and a capacity of 180 tph.

DOUBLE DRUM HOIST (200 hp) pulls skips up the 45° installation. Skips then empty automatically into the loading bins.

cars mentioned. Grades of main pit haulage roads are kept below 8%, and equipment available to maintain roadbeds in top condition includes a motor roller and water spray truck. Cleanup work in the pit is done with a diesel tractor equipped with a dozer blade.

The incline skip hoisting system serving the pit was designed and constructed by the company's mechanical department. It consists of a steel headframe, twin rail tracks laid on a concrete apron, two 2-cu m self-dumping skips, 200-hp double-drum hoist, and loading bins at the foot and top of the 45° installation. Total length of the skip tracks is 90 m. Capacity is 180 tph.

Underground operations are carried on at the rate of 450 tpd, with 225 men employed. This work is centered in exploiting scattered ore-shoots outside the economic pit limits. Two kinds of ore are mined—hard and medium soft. The three underground mine sections, known was Alfonso, Fortuna, and Nord, are served by a two-compartment 100-m shaft. Mining methods employed include sublevel caving in hard ground and cut-and-fill in areas containing medium soft ore. Drilling is done with push drills, using drill with forged on bits made from ⅞-in. hexagonal steel. Loading chutes in the haulage drifts are installed at 50-m centers. Broken ore is loaded into 1-ton cars and hauled in trains drawn by Hudson Hunslet locomotives to the shaft stations before transferring to the surface.

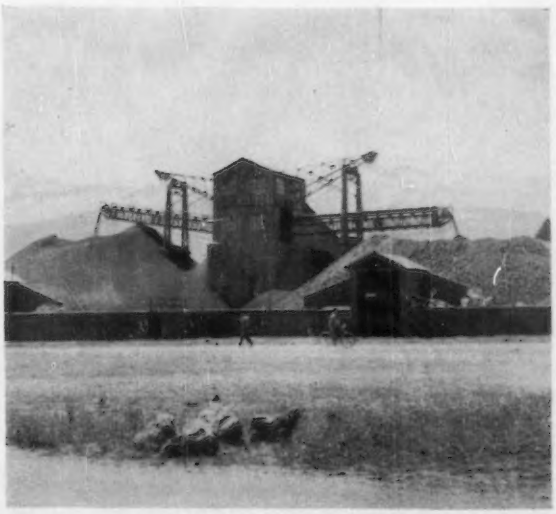
Total yearly mine production has increased steadily during the past few years. The 1957 production was 360,000 tons, that of 1958 some 420,000 tons, and the 1959 output is estimated at 500,000 tons, of which 130,000 tons came from the underground mines.

At the screening and sizing plant, pit and underground ores are dumped from the 25-ton Woodford cars and mine cars into receiving bins with a capacity of 2,000 tons and covered with 8x8-in. steel grizzlies. From here the material is withdrawn through underground chutes and feeders and belt conveyed to the screening and sizing section of the plant. Three sizes are made—namely, 0 to ½-in.; ½- to 2-in.; and 2- to 8-in. The 0- to ½-in. material and the combined ½ to 8-in. sizes are stockpiled separately. Capacity of the plant is 1,800 tons per 8-hr shift. Railroad cars are loaded by conveyor loaders with automatic weighing units installed at each stockpile. These go in trains to the Almeria harbor where a storage area capable of holding 70,000 tons of ore and modern loading facilities are available. Here an 8,000-ton ship can be loaded at the rate of 800 tph.

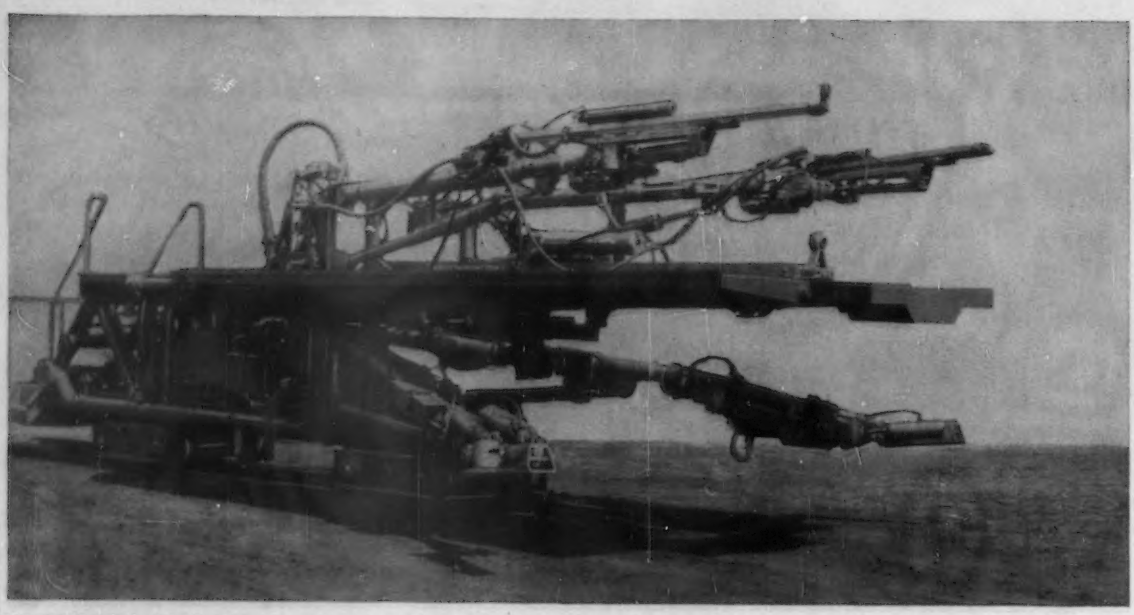
Electric power for the mine, surface plants, and company settlement is obtained from three sources: (1) Two hydro-electric plants operated by the company 11 miles from the mine, one producing 400 kw and the other 600 kw during the high water season and both using the Thury system; (2) three-unit diesel power plant at the mine with a maximum output of 1,000 kw; and (3) electric power contracted for from the local public utility, "El Chorro." Total power requirement is 1,300 kw. Compressed air for the pit, underground mines, and surface plant is furnished by three compressors housed in the diesel power plant.

The attractive company settlement covers an area of 100 hectares and consists of 85 modern dwellings scattered amid pines; a hospital equipment with X-ray unit, operating room, consulting and bedrooms; two schools; and club for the technical personnel; and a guest house.

E&MJ wishes to express its appreciation and thanks to the following executives for the many courtesies shown during the visit to the mine and at headquarters in Madrid: R. P. de Ceccaty, assessor general: Lamana de Hoyos secretary general; George Roziere; resident manager; and Michel Lecarpentier, mine superintendent.



SCREENING AND SIZING PLANT has a capacity of 1,800 tons per 8-hr shift. Ore is railed from here to Almeria harbor.



RECORD SET with Gardner-Denver equipped jumbo designed by Jacobs Associates, shown under construction. Note 5½-in. bore drifter for burn cut holes. Boom-mounted drifters positioned by remote control. Unit is semi-articulated.

Australians Use Burn Cut for Record

SETTING A TUNNELING SPEED RECORD only months after starting with a green crew is the remarkable feat of the Australian firm of Thiess Bros. Pty. Ltd. Last July, in a six-day period, this company advanced a 12.5 x 12.5-ft tunnel through granite from 11,108 to 11,634 ft at an average speed of 87.7 ft for a total gain of 526 ft.

The Thiess Bros. contract is part of the tremendous Snowy Mountains Authority project in the Great Dividing Range of southeast Australia. The Snowy Mountains of the main range forms the central and highest area of the Australian Alps. Snow clad for five or six months each year, the area is the source of the westward flowing Murray and Murrumbidgee rivers which cross dry, but otherwise fertile, plains stretching over hundreds of miles to the coast of South Australia. While irrigation farming in this area is already a well established industry, large-scale expansion of production depends on adding to the natural flow of these rivers.

The Snowy river, on the eastern slope, receives the greatest part of the run-off from winter snows, but it flows in the wrong direction to help the west. And it flows through an area where it is not particularly needed. The southeast coast of Australia enjoys ample annual rainfall.

The large flows of the Snowy start at a high altitude. By diverting them to the west and northwest through long tunnels under the divide the large difference in elevation between the eastern and western rivers can be used for power generation.

When completed, the Snowy Mountains project will have nine dams with a total storage capacity of nearly six million acre-ft of water; 57 miles of tunnel up to 22 ft dia; and 11 hydro plants with a generating capacity of over 2.5-million kw.

Owing to the magnitude of the project, most of the contracts have been given to firms from Europe and the United States. In 1958 Thiess Brothers was given the first major contract given to an Australian company.

Experience with projects of similar scope in western United States enabled the U.S. Bureau of Reclamation to lend valued assistance to the Snowy River project.

The Thiess contract is for the Tooma-Tumut diversion section of the Snowy Mountain project. Involved is construction of an earth and rock fill dam 220 ft high and a 9-mile tunnel connecting the Tooma reservoir with the Tumut Pond reservoir. The 12.5 x 12.5 ft tunnel is horseshoe-shaped.

Footages logged for the 6-day period follow:

July 27	92	ft.
" 28	81	"
" 29	77	"
" 30	69	"
" 31	96	"
Aug 1	111	"
Daily average	87.7	ft
Total rounds fired	52	
Average footage per pound	10.11	ft
Average depth of round	11.5	ft

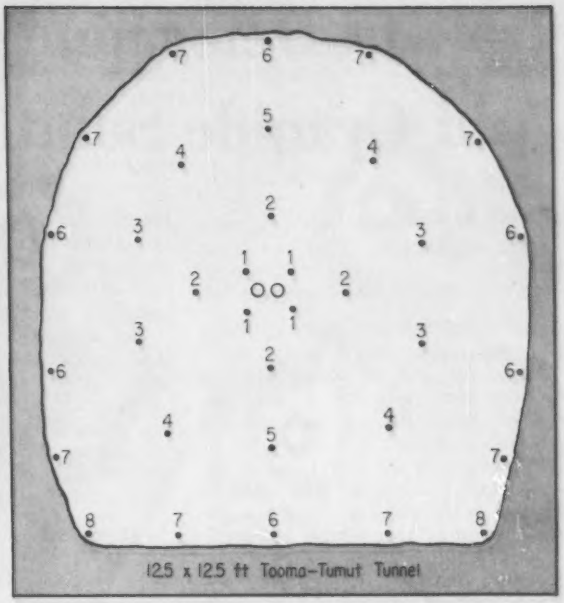
The tunnel goes through a variety of granites, but mostly biotite granite. Roof bolts furnish the only ground support that is needed.

The burn cut was used from the start of the tunnel. Several decades old, the burn has been found to pull deeper rounds than can angle cuts. Usually, in a burn cut, all holes are parallel, and in the center a pattern of blast holes is drilled around one or more "burn" holes which are not loaded. The unloaded holes give an open space into which the blast holes can break.

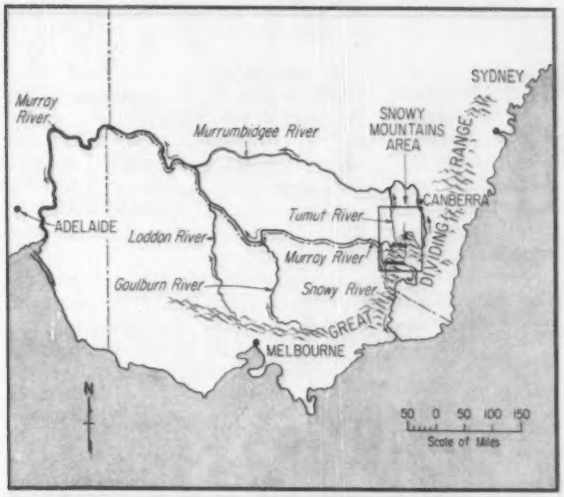
The burn cut round is easier to drill; fragmentation is better; over-all consumption of dynamite is lower; and the muck is left closer to the face than in other conventional cuts.

Thiess Bros. tried one pattern using 3-4-in. burn holes, and another with a single 8-in. burn. But the present pattern with 2-5-in. burn holes, 11.5-ft deep, with 34-1⅝-in. blast holes, was settled on.

3½ IN. BLAST HOLE, 5½ in. bore burn hole drifter have 6 and 12 ft feeds respectively. Burn holes are 5 in. dia.



THIESS settled on this as best pattern for ground. The two center holes are not loaded, giving a free face to break to.



WATER FOR ARID WEST and power for industrial expansion will come from diversion of water from range's east slope.

Equipment

Drills and Jumbo: Gardner-Denver and Jacobs Associates (see text).

Compressors: 8-800 cfm Broomwades driven by 180 hp 975 rpm Brush motors.

Shovels: Goodman Conway "75", 1 cu yd bucket. A "60" Conway on stand-by.

Cars: 6-cu yd side tipping Hudson.

Drill bits: 5 in., 1-¾ and 1-⅜ in. Timken tungsten carbide.

Drill steel: 1-¼ in. round, hollow core in 6 and 12 ft lengths.

Locomotives: Two Commonwealths with 180 hp Rolls Royce diesel engines. One Malcolm Moore with 68 hp diesel. One Ruston Hornsby with 47-1 G. M. diesel.

Fans: 3-36-in. Contrapoise, type CRT axial flow, 18,000 cfm, each with 2-30 hp 1440 rpm AEI motors

Vent line: 33 in. dia., 16 ga mild steel in 20 ft lengths.

Vent line erector jumbo: Jacobs Associates design—powered by 1.5 hp Crompton Parkinson electric motor, fitted with Gardner-Denver hydraulic pump unit. Jumbo is semi-articulated.

Water and air lines: The 8 x 4-in. steel pipe use Victaulic fittings.

AN60% Gelignite dynamite with milli-second delays were used on the job. Dynamite consumption was 5.28 lb per cu yd of rock in place.

Each shift was staffed as follows:

Walker	1
Shifter	1
Miners, 1st class	8 (incl. Conway
Miners, 2nd class	4 shovel oper's)
Shift electrician	1
Shift fitter	1
Locomotive drivers	3
Brakemen	2
Pumpman	1
	22

The steel fabricated, articulated jumbo was designed by Jacobs Associates, consulting engineers of San Francisco. The drilling equipment was all furnished by Gardner-Denver as follows: Six SF93 3½-in. bore drifters on 6-ft power screw feeds; one DH143 5½-in. bore drifter on a 14-ft power screw feed. The six drifters are mounted on JTB Tripod type hydraulic booms equipped with DPU hydraulic drill positioners, remotely controlled.

One compelling influence which brought about the Snowy Mountain project is the tremendous influx of immigrants. And it was from these new citizens from many nations that Thiess Bros.' crews were drawn. Not only were the men green at tunnel work but it was necessary to overcome a severe language barrier. Despite these drawbacks a polished performance of men and machines made the record possible.

The men who directed the operation are: Les Thiess, managing director of Thiess Bros.; Stan Thiess, New South Wales director of Thiess Bros.; John W. Redpath, general manager of the project, and A. L. Lloyd, his assistant; Whitey Dunbar, general tunnel superintendent; and Paul Cellitti, superintendent in charge of the Deep Creek adit of the Tooma-Tumut tunnel where the record was set.

How to Determine Selenium in Ores And Cyanide Solutions

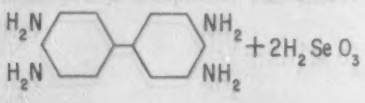
MERLE I. EISS
PAUL GIESECKE

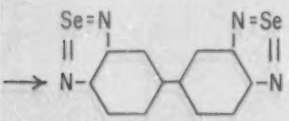
SELENIUM frequently occurs in Mexican gold-silver ores. In the cyanidation of the ores to extract precious metals, some selenium is also dissolved. When the pregnant cyanide solution is treated with zinc dust to precipitate gold and silver, part of the selenium is precipitated. The selenium content of the precious metal precipitate can be of considerable economic value due to the increasing use of the metal in industry. Therefore, an accurate method of analysis for small amounts of selenium in ores, pregnant and barren cyanide solutions and precious metal precipitates is necessary.

A problem involving the precipitation of selenium from pregnant solutions, which was submitted to the research laboratory of the American Cyanamid Co., led to an investigation of various analytical methods.

An attempt was made to use the old turbidimetric method[1] for selenium analysis. The method consists of bubbling SO_2 through a sample acidified with hydrobromic acid to form a colloidal suspension of elemental Se. However, erratic results were often caused by the precipitation of gold and silver along with the selenium. Therefore, the colorimetric method of Cheng[2] using 3,3′-diaminobenzidine as a reagent for selenium was adapted for our purposes.

The reagent, 3,3′-diaminobenzidine, reacts with selenium to form an intense yellow compound, piazselenol:





Piazselenol is stable in acid, neutral or alkaline solutions and can be quantitatively extracted at a pH above five with benzene or toluene. Other metallic ions are prevented from interfering with color development by the addition of ethylenedinitrilotetracetic acid (EDTA) which forms colorless complexes with most metals.

The method gave excellent results in the recovery of selenium from water solutions, but recovery of standard additions of selenium from cyanidation solutions was poor. The sample was not treated with heat or nitric acid and sulphides were not removed. Results were as follows:

μg Se added	μg Se found
8	4.4
8	5.2
16	8.8
16	8.8
16	8.3
24	12.2
32	16.5
32	15.9

Since metals generally do not interfere with the test[2], standard additions of known anion impurities were added to pure cyanide solutions. HCN_2^-, CNS^-, $SO_4^=$, and $CN_2^=$ (0.1 to 1% level) did not interfere, but 1% sulphide caused a marked decrease in selenium recovery. In the procedure, the solution was not treated with heat or nitric acid. Se recovery was lowered as shown below by the addition of 1 to 2% sulphide to pure cyanide:

1% sulphide		2% sulphide	
μg Se added	μg Se found	μg Se added	μg Se found
8.0	5.1	8.0	3.1
16.0	9.0	16.0	5.9
20.0	9.4	24.0	9.2
20.0	8.2		
24.0	13.0		
30.0	20.7		

Addition of litharge (PbO) to the solution to remove sulphide was not successful, nor was an attempt to oxidize sulphide to sulphate and to eliminate sulphate with ammonium chloride.[3] Digestion of the cyanidation material in acid solution to remove H_2S resulted in a large loss of selenium due to volatilization.

Best recovery was obtained by evaporating neutral to alkaline cyanidation solutions to dryness at 75° C on a steam bath, cooling and then adding only two to five drops of fuming nitric acid. A few minutes on the steam bath was sufficient to eliminate the sulphide and any unreacted nitric acid, and the selenium was retained. Replicate samples of both "Aero" brand cyanide and sodium cyanide solutions were analyzed by the procedure. Selenium values had an average negative bias of 3.5% relative—probably due to a slight loss of selenium in the preparation steps. The following table shows Se recovery for solutions containing 1% sulphide after treatment by evaporation and fuming nitric acid, then analysis by the 3,3′-diaminobenzidine procedure. The 1% sulphide is based on cyanide.

μg Se added	μg Se found
10.0	9.4
20.0	18.7
20.0	19.8
20.0	19.5
20.0	19.0
30.0	28.7
30.0	29.9
30.0	29.1
30.0	28.9

A sample of Mexican gold-silver-selenium ore which contained 7.5 g per metric ton gold and 437 g per metric ton silver (1 g per metric ton equals 1 ppm) was analyzed directly for selenium by dissolving 7- to 10-g samples in 1:1 nitric-hydrochloric acid. About 58 ppm selenium were found in the ore.

Two analyzed samples of selenium-bearing ores received from the U.S. Bureau of Mines' Intermountain experiment station were analyzed by the method. Results are listed below.

Sample	Bureau of Mines analysis (%Se)	3,3′ diaminobenzidine reagent analysis (%Se)
1. Flue dust from molybdenum roasting	1.01	0.88, 0.90, 0.89
2. Low uranium ore	0.071	0.068, 0.072, 0.070, 0.068

Sample No. 1 was flue dust from a molybdenite roasting operation. The dust was rich in molybdenum oxide and also contained some rhenium. Sample No. 2 was a low-tenor uranium ore that contained pyrite and carbonaceous matter. From 0.5 to 1.0 g of ore was digested for a minimum of three hours at room temperature in 70 ml of 1:1 HNO_3-HCl, then made to 100 ml with H_2O. A 1-ml aliquot was then evaporated to dryness on a steam bath. Next, 10 ml of 0.1M EDTA was added and warmed until the residue was dissolved. Then the

Mrs. Eiss is presently employed as a chemist with Food Machinery & Chemical Corp. of Baltimore. Mr. Giesecke is a group leader, visible spectroscopy laboratory of the American Cyanamid Co. in Stamford, Conn. The work was originally done in connection with cyanidation studies of Mexican gold-silver ores by the company.

3,3′diaminobenzidine procedure was followed.

Making the Analysis

Apparatus and reagents used in making Se determinations at the Cyanamid laboratories were as follows:

1. G.E. recording spectrophotometer, although any simple photoelectric colorimeter may be used. Corning filter No. 5113 is recommended.
2. pH meter
3. Centrifuge
4. Formic acid—2.5M
5. $Ca(CN)_2$ and NaCN—0.05% aqueous solutions
6. 3,3′—Diaminobenzidine hydrochloride—0.5% solution prepared fresh daily and obtained from Dr. K. L. Cheng, Kelsey-Hayes Co., Utica, N.Y. or Baker Chemical Co.
7. EDTA—0.1M solution disodium salt of (ethylenedinitrilo) tetra acetic acid.
8. Standard selenium — 16.8 mg selenous acid (H_2SeO_3—97.4% assay) are dissolved in 1,000 ml of water (10 μg Se per ml solution).
9. Benzene—reagent grade
10. NH_4OH—7M
11. Fuming HNO_3

The analytical procedure is to place an aliquot of the cyanidation solution containing 5-35 μg Se in a 100 ml beaker. Evaporate gently to dryness at 75°C. Cool, add two to five drops of fuming HNO_3 and evaporate again just to dryness—two to three minutes. Add 10 ml of 0.1M EDTA. Adjust pH to two to three with 2.5M formic acid (about 2 ml). Add 2 ml of 0.5% diaminobenzidine to the solution and allow to stand 30 minutes. Adjust the pH to six or seven with 7M NH_4OH. Transfer the solution to a 125 ml separatory funnel, add exactly 10 ml of benzene and shake vigorously about 30 seconds. Transfer the benzene to a 15-ml centrifuge tube and spin at 2000 rpm for a few minutes. Separate the clear benzene layer and measure its absorbance at 420 mμ in a 1-cm cell. Run a reagent blank with each set of samples.

For an ore sample or precious metal precipitate, take up to a 10-g sample and allow it to dissolve in 1:1 HNO_3-HCl overnight at room temperature or to digest for two hours in a system closed with a reflux condenser. Filter solution from the insoluble material, then wash, make to volume and proceed as with the cyanidation solution. To prevent the loss of Se by volatilization, arrange the sample weight and volume such that a small aliquot is used for the analysis.

Prepare a calibration curve by taking 5-, 10-, 15-, 20-, 25-, and 30-μg aliquots of standard selenium and develop color as above. Absorbtivity equals 11.0 per 1.0 mg per 10 ml per 1-cm cell at 420 mμ (G.E. spectrophotometer). Absorbtivity will vary with the spectral resolution of the instrument used.

Considering the Results

3,3′-Diaminobenzidine is stable in aqueous solution for one to two days if kept under refrigeration. If left overnight at room temperature, it turns red and is no longer usable.

A large excess of the color reagent, 3,3′-diaminobenzidine, tends to give high results.

Excess heat and too much nitric acid lowers the selenium recovery (Since selenium is fairly volatile above room temperature, it is probably lost during the longer period of time required to evaporate the larger amounts of nitric acid.) The final pH of the solution must be between six and seven.

The authors wish to thank N. Hedley and H. Tabachnick of the mining chemicals laboratory, American Cyanamid Co., for their information about ores and the cyanidation process, and J. P. Habermann for analyzing the ores and cyanide solutions.

References:

[1] Journal of the American Chemical Society, 1925, Vol. 47, p 469.
[2] Analytical Chemistry, 1956, Vol. 28, No. 1, p 1738.
[3] Analytical Chemistry, 1958, Vol. 30, No. 8, p 1370.

For Safety's Sake, Try Job Analysis

WHEN JONES & LAUGHLIN STEEL CORP. opened the Tracy mine, Negaunee, Mich. in 1951, the management tried occupational and job analysis in a successful attempt at cutting the mine accident rate. Occupational and job analysis, performed with the assistance of the more skilled employees and the supervisors, proved to be a much better approach to the problem of training inexperienced miners than the simple handing out of safety codes and rule books.

Since most of the men employed at the new mine were inexperienced, it was possible to train them to the job as well as in the proper safety habits at the same time. On the occupational level—as well as the individual job level—the safety department worked with the miners to set down in operating manuals the step-by-step job operating sequences. Alongside these operating steps, they wrote down the hazards to be encountered at every step of the way and the means of preventing mishaps.

Each Job's Hazards Noted

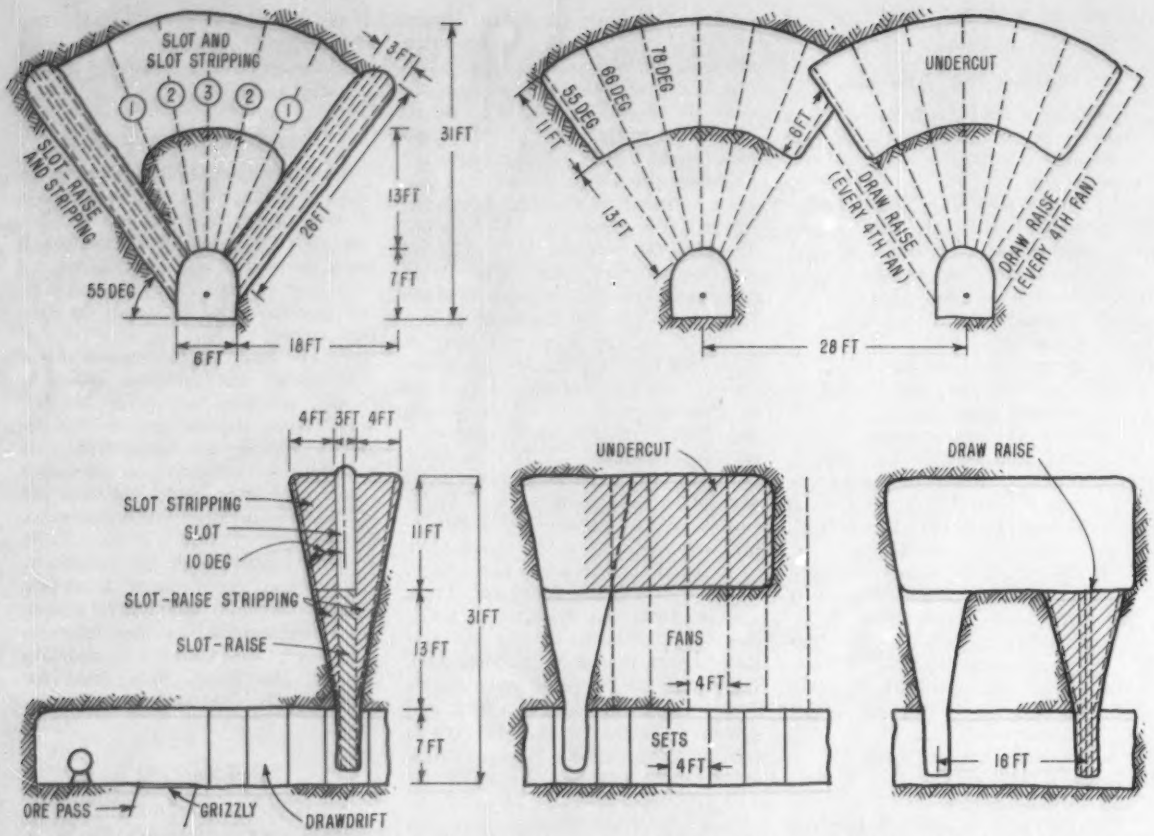
When the manuals were completed, each occupation and each job had been written up and every conceivable job hazard had been accounted for at the same time—providing J&L management with an ideal job and safety training manual. Each man was trained through the manuals in his particular occupation and job by his immediate supervisor.

Today, each new employee is taken through the manual by his supervisor when he comes on the property or changes occupations or jobs. Periodically, the supervisors are required to re-emphasize the lessons in the safety analyses.

Employee participation from the very beginning was one of the main reasons for the success of the program according to R. E. Prittinen, supervisor of personnel relations, at Tracy —"As long as the employee feels that he is a part of the program, he normally will be more inclined toward good safety habits." Another advantage stressed by Mr. Prittinen in his paper before the National Safety Congress is that the supervisor clearly recognizes the hazards and safety measures required on every job under his immediate supervision.

Another essential is that the supervisors must continually review the manuals. According to Prittinen, occupational and job analysis provided Tracy mine with a vastly better safety training program than could be provided by the issuance of the ordinary safety rules books and codes.

Based on a paper presented by R. E. Prittinen, supervisor of personnel relations Jones & Laughlin Steel Corp., Tracy mine, Negaunee, Mich., before the 47th annual National Safety Congress, Chicago, Ill. Oct. 19 to 23, 1959.



BASIC PATTERN in radial drilling method of undercutting caving block is used to cut slot between tops of two raises, then advance undercut proper down drift. Draw raises are cut as needed. Area of undercut is widened from adjacent drift.

Undercutting From Draw Drift Pays Off At Cleveland Cliffs' Mather "A" Mine

OIVA W. HAKALA

VERTICAL FANS OF UPHOLES, drilled from the draw drift and progressively blasted so as to enlarge an initial undercut-level slot leaving a pillar over the drift, have proven exceptionally safe and efficient for undercutting caving blocks at the Mather Mine "A" Shaft of Cleveland-Cliffs Iron Co. in Ishpeming, Mich.

Such a "radial drilled undercut" is started by driving an inclined raise from each side of an end of the draw drift up to the top of the proposed undercut. The ground between the top portions of this pair of raises is removed to make the initial slot on the undercut level. It is removed by fans of long up-holes drilled from the draw drift. Only the deeper half of each hole is charged and each hole is blasted in sequence so that the hanging-wall of each raise is slabbed off until the openings meet directly over the drift pillar.

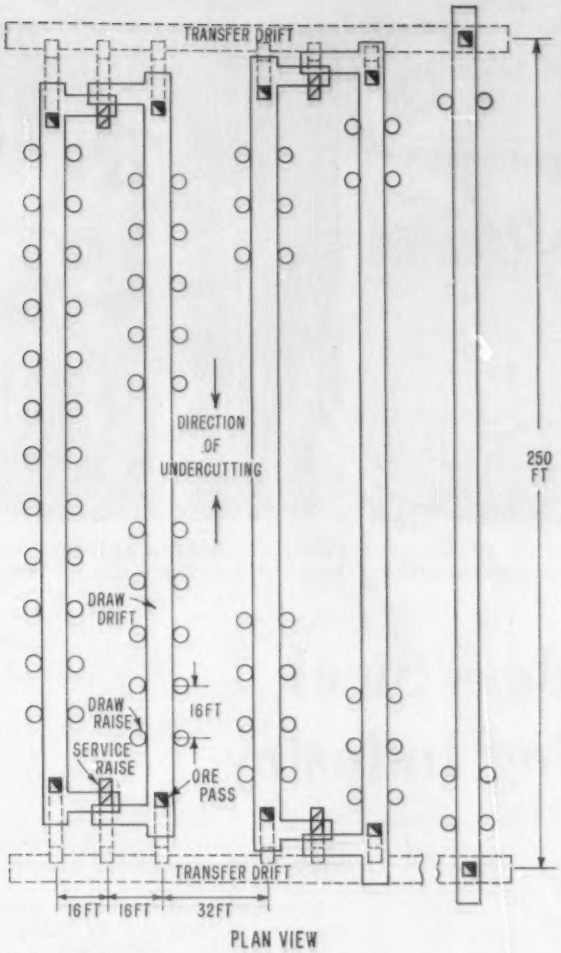
The undercut proper is then excavated in slices by drilling and blasting parallel vertical fans of long up-holes while advancing down the drift away from the initial slot. Only the deeper half of the holes in each fan is charged and all holes in a fan are blasted simultaneously. This procedure leaves a continuous pillar over the drift. At suitable intervals, draw holes are broken up into the advancing undercut.

The undercut area is further enlarged in the same way from the adjacent parallel draw drift. At the Mather "A", undercutting is done from both ends of a draw drift concurrently, working toward the center of the block. The entire undercutting operation proceeds from one side of the caving area, draw drift by draw drift, retreating back toward the main ore pass.

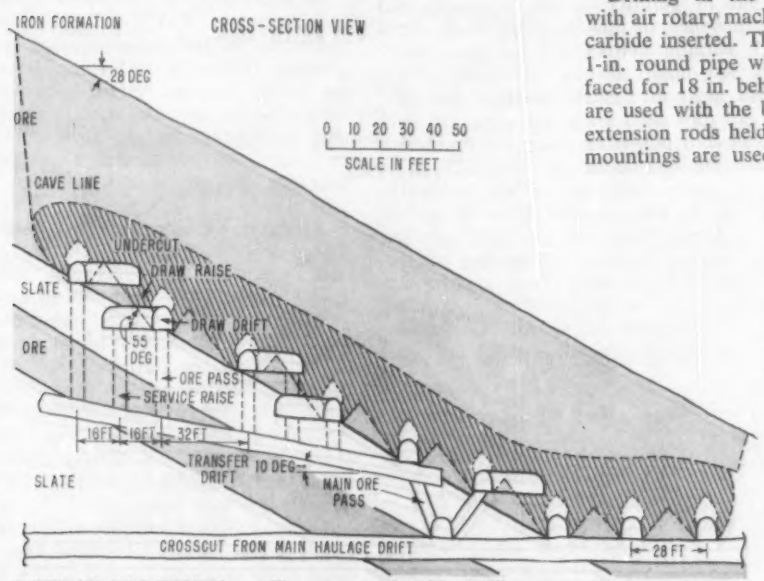
Safety is enhanced by the permanence of the draw drift. Men need never enter the undercut. Yieldable steel arches, lighting and power, as well as ventilation and ore-handling equipment can be installed as the block is developed.

Efficiency of the operation is promoted not only by the use of permanent facilities but also by the improved drilling and blasting practice. This practice more than offsets the slight loss in effectiveness of hole-footage near the collar of the holes. For one thing, most of the drilling is on set-up-time-saving long-holes. Also, on the undercut level, no conventional drifting or raising is necessary. Thus, hole burden can be larger because of the large

Mr. Hakala is operating engineer at the Mather Mine, "A" Shaft, of Cleveland-Cliffs Iron Co. at Ishpeming, Mich.



WORK PROCEEDS from both ends of a draw drift toward center of the block. Drawholes are opposite each other in a given draw drift but are offset half the interval in adjacent draw drifts. Transfer drift leads to the main ore pass.



DIPPING ORE ZONE is readily accommodated by drilling somewhat longer holes on the up-dip side of each fan and somewhat shorter holes on the down-dip side.

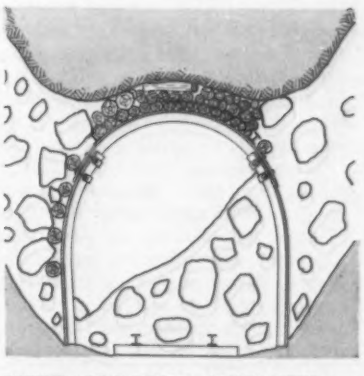
DRILLING SOFT SPECULAR-HEMATITE is commonly done with rotary machines and auger-type drilling string.

free face exposed to the explosion forces. Hole spacing can also be large at the toe because of the powerful between-hole breaking effect that results from blasting all holes in a row simultaneously, and because a certain amount of "bootlegging" can be tolerated. This improves the drillhole and powder factors.

In addition, a possible gain in blasting efficiency could come from the long collar of hole that must remain intact, permitting better confinement of explosive because a much greater length of hole can be stemmed. However, CCI gets excellent results by using a single 2-in. long stemming plug of loose asbestos material, into which is driven a small conical wooden wedge that seats the plug securely.

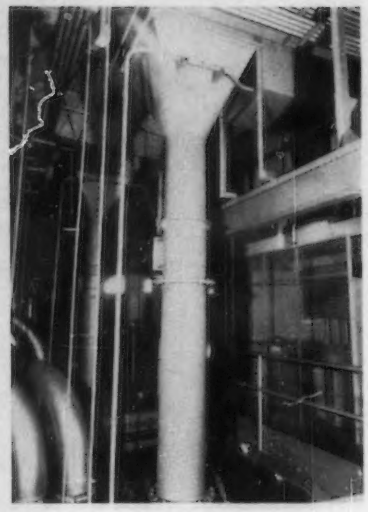
In developing a block caving area at the Mather "A", ore gathering facilities are completed before undercutting begins. Electric slushers are used in the draw drifts as well as in the transfer drifts serving the draw drifts. At other mines in the district, however, chain conveyors are often used for gathering in the draw drifts. Wire-rope suspended belt conveyors are frequently used for the longer gathering hauls, especially from the transfer drifts to the main rail lines that go to the shaft. The most satisfactory belt-loading scheme has been found to be chutes equipped with reciprocating plate feeders.

Drilling in the specular hematite is generally done with air rotary machines. Bits are 2-in., two-finger, tungsten carbide inserted. The drill rods are sectional, 3 ft long, of 1-in. round pipe with welded-on auger scroll that is hard faced for 18 in. behind the bit. Male to female connections are used with the bit shank held by a cotter pin and the extension rods held by a spring button. Column and arm mountings are used for fan drilling.



YIELDABLE STEEL ARCH SETS now furnish ground support in draw drifts.

STAINLESS STEEL SHEATHING protects the full exterior of this Peabody Coal Co. preparation plant. Type 302 siding was selected to reduce maintenance costs.



STAINLESS HOPPER AND CHUTE is fabricated from 304 metal-clad sheet.

How to Select Stainless Steel For Use in the Mining Industry

RICHARD E. PARET

Part 1. Principles of Selection

STAINLESS STEEL is a premium construction material in many respects. Both in purity of constituents and in control of alloy composition, the metal is generally agreed to be of exceptional quality. Because of its rugged ability to withstand severe service conditions, stainless has become the metal of choice for many industries on a purely economic basis.

Economy measured in terms of amortized cost is most often the reason for use of stainless in mining and ore refining. In such service, severe demands upon equipment can lead rapidly to performance deterioration and high maintenance costs unless adequate provision is made at a design level through choice of the proper construction materials.

Where stainless steel is specified for mining equipment, designers normally choose it because no other less costly material will perform as adequately. The more rugged are the service conditions, the more likely is stainless to be employed. Rarely will stainless prove unable to cope with the corrosive conditions of mining or refining service. It thus is to be expected that the stainless steel alloys should enjoy wide acceptance.

Mr. Paret represents the Committee of Stainless Steel Producers, American Iron and Steel Institute, New York, N. Y.

Reasons for this acceptance are to be found in the basic properties that distinguish the stainless steel alloys from other materials. No other family of metals supplies the combined advantages of high corrosion-resistance, high and low temperature strength, low maintenance costs, abrasion resistance, toughness and durability, in as great a variety of surface finishes as the various stainless alloys. Several or all these properties enter into specification of stainless for mining and refining equipment. Their relative importance and the specific stainless alloy selected will depend upon the particular service environment encountered.

Properties of Stainless

The family of stainless steel alloys presently comprises 38 distinct compositions, each originally developed to answer a specific need. Table I lists those stainless alloys found suitable through past experience for mining and/or ore refining service. They may be grouped in three basic classes, each with its own physical, mechanical, and corrosion-resisting qualities.

Martensitic hardenable steels. Stainless alloys 410 and 416, for example, contain chromium and carbon as the active alloying ingredients. They can be hardened by heat treatment to high strength levels and are magnetic.

Ferritic non-hardenable steels. Stainless alloy types 430 and 446 include chromium as the major alloying ingredient. Unlike the martensitic alloys, the ferritic stainless grades normally are used in the annealed state in which they demonstrate maximum ductility and corrosion resistance. They are magnetic.

Austenitic non-hardenable steels. These alloys include types 301, 302, 304, 305, 308, 309, 310, and 316. They contain both chromium and nickel, and thus afford somewhat greater corrosion resistance than either the martensitic or ferritic alloys. Although non-hardenable by heat treatment, they may be appreciably strengthened by cold working. All types are non-magnetic. Of the grades cited, type 302 is by far the most frequently specified.

Generally speaking, the following traits distinguish stainless steel from other metals:

Corrosion-resistance. All the stain-

Table I. Properties of Selected Stainless Steels

AISI type nos.	Purpose of alloy	Simplified table of compositions (approximate percentages) Cr	Ni	C max	Other	Representative mechanical properties (annealed sheet) Tensile strength psi Room temp.	Tensile strength psi —80° F	Yield strength psi Room temp. F (.2% offset)	Yield strength psi —80° F	Heat treatment (deg F) Annealing	Heat treatment (deg F) hardening	Fabricability C	M	F	J	Fi
Work Hardening Chromium-nickel (austenitic) Alloys																
301	Structurals-high strength, high ductility	16.00/ 18.00	6.00/ 8.00	0.15		110,000	195,000	40,000	50,000	1850–2050 (b)		2	2	2	2	2
302	General purpose	17.00/ 19.00	8.00/ 10.00	0.15		90,000	161,000	40,000	50,000	1850–2050 (b)		2	2	2	2	2
304	Low carbide precipitation during welding	18.00/ 20.00	8.00/ 12.00	0.08		85,000	170,000	35,000	34,000	1850–2050 (b)		2	2	2	2	2
304L	Lower carbide precipitation during welding	18.00/ 20.00	8.00/ 12.00	0.03		75,000	170,000	28,000	34,000	1850–2050 (b)		2	2	2	2	2
305	Spin forming and severe drawing	17.00/ 19.00	10.00/ 13.00	0.12		85,000		38,000		1850–2050 (b)		2	3	2	2	2
309	High temperature strength and scale resistance	22.00/ 24.00	12.00/ 15.00	0.20		90,000		45,000		1900–2050 (b)		2	3	2	2	2
309S	Low carbon precipitation during welding	22.00/ 24.00	12.00/ 15.00	0.08		90,000		45,000		1900–2050 (b)		2	2	2	2	2
310	Higher elevated temperature strength and scale resistance than Type 309	24.00/ 26.00	19.00/ 22.00	0.25		95,000		45,000		1900–2100 (b)		2	3	2	2	2
310S	Low carbide precipitation for welding	24.00/ 26.00	19.00/ 22.00	0.08		95,000		45,000		1900–2100 (b)		2	3	2	2	2
316	Higher corrosion resistance than Types 302 & 304 high creep strength	16.00/ 18.00	10.00/ 14.00	0.08	Mo 2.00/ 3.00	90,000	118,000	40,000	44,000	1850–2050 (b)		2	3	2	2	2
316L	Low carbide precipitation during welding	16.00/ 18.00	10.00/ 14.00	0.03	Mo 2.00/ 3.00	90,000	118,000	40,000	44,000	1850–2050 (b)		2	3	2	2	2
D-319	Modified 316 for improved corrosion resistance	17.50/ 19.50	11.00/ 15.00	0.07	Mo 2.25/ 3.00	90,000 (f)	118,000 (f)	40,000 (f)	44,000 (f)	1850–2050 (b) (f)		2	3	2	2	2
321	Stabilized for weldments subject to severely corrosive conditions and for service in 800° to 1600° F temperature range. (No carbide precipitation)	17.00/ 19.00	9.00/ 12.00	0.08	Ti 5 x C min	90,000		35,000		1750–1950 (b) Stabilizing 1550–1650		2	3	2	1	2
347		17.00/ 19.00	9.00/ 13.00	0.08	Cb-Ta 10 x C min	95,000	130,000	40,000	45,000	1850–2050 (b) Stabilizing 1550–1650		2	3	2	2	2
Hardenable Chromium (martensitic) Stainless Alloys																
410	General purpose, rotating parts	11.50/ 13.50	.....	0.15		65,000	128,000	35,000	94,000	Full anneal 1500–1650 (c) Low anneal 1200–1400	1700–1850 (b)	2	2	2	2d	2
416	Type 410 alloyed for high machinability	12.00/ 14.00	....	0.15	Mo 0.60 max Zy 0.60 max (optional)	75,000 (a)		40,000 (a)		Full anneal 1500–1650 (c) Low anneal 1200–1400	1700–1850 (b)	2	1	3	4	3
420	Cutlery, surgical instruments, valve, wear resisting parts	12.00/ 14.00	.....	Over 0.15		95,000 (a)		50,000 (a)		1500–1650 (c) Low anneal 1350–1450	1800–1900 (b)	2	3	3	2d	2
440	Premium grade stainless cutlery, valve, other wear resisting & high hardness parts	16.00/ 18.00	....	0.75 0.95	Mo 0.75 max	107,000 (a)		62,000 (a)		Full anneal 1550–1650 (c) Low anneal 1350–1450	1850–1950 (b)	2	3	3	2d	2
Non-hardenable Chromium (ferritic) Stainless Alloys																
405	Weldments where 12% chromium gives sufficient corrosion resistance	11.50/ 14.50	.....	0.08	Al 0.10/ 0.30	65,000		40,000		Low anneal 1350–1500	Not appreciably hardenable	2	2	2	1	2
430	General purpose	14.00/ 18.00	.....	0.12		75,000	81,000	45,000	44,000	Low anneal 1400–1500	Not appreciably hardenable	2	2	2	2	2
446	High resistance to corrosion and scaling at high temperature (g)	23.00/ 27.00	.....	0.20	N 0.25 max	80,000		50,000		Low anneal 1450–1600	Not hardenable by thermal treatment	2	2	3	3	2

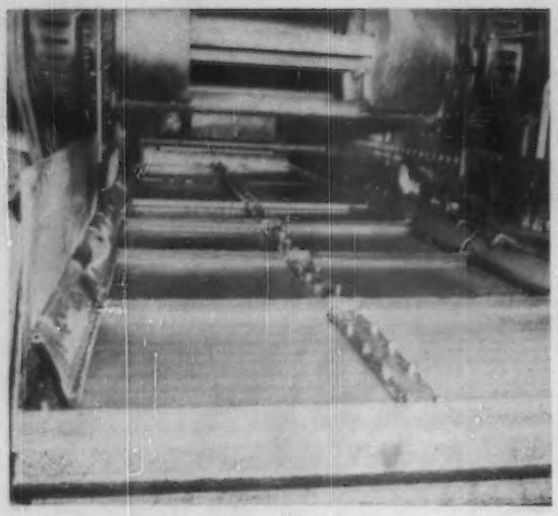
NOTE: Weldability ratings for any one alloy are comparable only with those in the *same group* (including austenitic, martensitic or ferritic.

Fabricability symbols: C, cutting; M, machinability; F, forming; J, joining; Fi, finishing.

(a) Figures given for barstock; sheet data unavailable. (b) Followed by rapid cooling. (c) Followed by slow cooling. (d) Weldable, but preheat and/or post heat usually recommended to prevent cracking. (e) Slightly more care, due to high chromium content. (f) Preliminary and subject to revision. (g) Especially good for intermittent service. Often used in preference to chromium nickel types in sulphur-bearing atmosphere.

less steels withstand attack by corrosive agents better than carbon and low alloy steels and than most other materials. Unlike the corrosion protection applied to most other metals, this resistance to attack is not superficial, but rather extends throughout the entire metal thickness. Mechanical damage to a stainless alloy leaves the metal beneath it fully resistant to further attack. With most coated, plated or surface-treated materials, in contrast, metal underlying degrades rapidly under corrosive attack when the protective surface layer is damaged. The intrinsic resistance of the stainless steels to corrosion supplies a valuable safety factor built into each piece of mining equipment, and helps to assure durable and long-lasting installations.

Protection of the stainless steel surface is understood to occur through formation of a mechanical film of ox-



SHAKER SCREENS of stainless steel outlast those made of carbon steel by a factor of two to one. Type used, 316.

HYDRAULIC CLASSIFIER is made of stainless to withstand abrasive slurry and acidic water. Type used, austenitic.

DISK-TYPE FILTER of stainless-steel cloth is more than twice as efficient as cotton cloth filter fabric formerly used for separation of ore concentrates.

ide. This tough film enables the metal to withstand not only oxidizing atmospheres, but also liquids and solids containing oxidizing agents. In the latter class are found many organic and inorganic acids, and most of the corrosive salts employed in the mining and refining of metal.

Exposure of the stainless alloys to reducing environments must not always be presumed detrimental to the metal. In some instances, stainless steel is preferred over other materials. Commonly encountered in the mining industry is preferential use of stainless steel where need for other properties will outweigh desire for a material fully resistant to the action of reducing agents. For example, such preference could arise from the higher costs or lower abrasion resistance of other materials.

Toughness and abrasion resistance. Stainless steel can and is being selected for mining and refining equipment on the basis of abrasion resistance alone. Where corrosion is no problem, relative ease of stainless fabrication and comparative low cost can lead to a designer choice of the metal for its toughness. In severely abrasive service, steels alloyed with tungsten or manganese sometimes are preferred to stainless. But couple abrasive environments with even moderately corrosive service, and the choice frequently reverts to a member of the stainless family.

High and low temperature properties. Austenitic stainless steel is accepted as a tough, high strength material for use not only at temperatures approaching absolute zero but also at continuous service at temperatures up to 1,800°F. for selected alloys. Metallurgically speaking, good reasons exist for this broad spectrum of useful service. To the mining engineer, this means that once an austenitic stainless grade has been selected for a maximum operating temperature, it also will prove suitable for virtually all lower temperatures. Austenitic stainless retains its strength at low temperatures without becoming unduly brittle, a property that leads to its use under dramatically severe climatic conditions. Stainless space heating equipment exposed during off-shift hours to subzero temperatures is an example.

Surface finish. Smooth surfaces or their lack can greatly influence performance of some mining and refining equipment. Acceptance by stainless of a variety of surface finishes, ranging from rough through highly polished, greatly enhances the versatility of the alloy for mining uses. The corrosion resistant trait of stainless insures surface smoothness as that when first installed. Low sliding friction results, a tangible asset in some materials handling equipment. Ore concentrate hoppers of stainless, for example, generally are more free of "arching" than similar equipment of other materials.

High strength, low weight. Wherever loads must be carried, the high strength/weight ratio of stainless steel makes it a material for consideration. Type 301, in particular, will work harden, as do the manganese steel alloys, to extremely high tensile strengths.

The heat and corrosion resistance of this and other stainless alloys also permit designing structural sections of

Table II. Cost Analysis of Mine-Installed Bell Cable

Material	Galvanized wire	Type 302* stainless steel wire
Cable diameter, in.	0.25	0.15625
Cost, per 100 ft	$10.16	$25.75
Life, months	6	71
Cost, per month of life per 100 ft	$1.69	$0.36
Estimated savings		79%

* Subsequently adopted as mine standard. Cable is 7 x 19 ply, 600 to 800 ft long, 2,600 psi breaking strength.

Source: Coordinated data from Creighton, Frood, Garson, and Levack mines. Sudbury area, Canada.

Table III. Cost Analysis of Installed Mine Water Drain Pipe*

Material	Wall thickness, in.	Flange pressure rating, psi	Life, months	Cost per ft
Rubber lined steel	0.365	150	36–60	$21.14
	0.365	300		22.32
Type 304 stainless	0.141	150	equal	15.17**
	0.141	300	or	17.82**
	0.1875	300	better	21.78

* 10.75-in OD pipe pump column.

** Subsequently adopted as mine standard.

Source: Frood-Stobie Mine, Sudbury area, Canada.

Table IV. Cost Analysis of Installed Manway Ladder Rungs

Material	Rung dia, in.	Wt/ft lb	Cost/ lb	Cost/ rung	Life, months	Cost/ year
Mild steel	⅞	2.04	6.8¢	18.2¢	36	6.1¢
403 stainless	¾	1.50	25.5¢	51.0¢	240*	<2.5¢*

* Estimated.

Source: Tests in acid mine water in No. 3 shaft, Frood Mine, Sudbury area, Canada.

minimum thickness with no allowance for corrosion necessary. Type 302 stainless, when work hardened, provides strength levels only slightly lower than type 301.

Ease of fabrication. Despite their strength and toughness, many of the standard stainless steel alloys display fabricability, making them more suitable than many other materials for use in mining equipment. Among the stainless steels are grades especially formulated for easy machinability, including types 303, 416 and 430F. Type 308 is alloyed for maximum weldability, and finds frequent use as a welding rod material. Austenitic stainless alloys possess an inherent ductility which makes it generally feasible to omit stress relieving after weld fabrication.

CORROSION PROBLEMS caused by acids contained in copper concentrate were solved by using stainless steel in this bucket at a Western copper smelter.

How to Select Stainless

In selecting an appropriate stainless grade for mining and/or refining equipment, the first step is a checklist of service requirements. Comparison of this list with service conditions in known and successful stainless applications should follow. Service experience with the stainless alloys in the mining and/or refining field now is extensive. Actual tables to be presented in a later article will summarize field experience in the following areas: mining and ore removal, size reduction and grading, concentrating, smelting, and refining. From these tables, some estimate of anticipated performance can be extrapolated, although actual service experience should always be the prime consideration.

Degree of corrosion resistance required is of prime significance. Where dimensional stability or long-term surface smoothness is important, the stainless grade selected must be essentially immune to the environment. However, in some cases a predictable rate of corrosion is tolerable. Choice between corrosion-resistant and immune grades of stainless will call for an economic evaluation of recorded or expected service life.

Mildly corrosive conditions permit use of almost any stainless steel alloy. Severely corrosive service may restrict choice to one or possibly two stainless alloys. Similarly, service at continuous temperature above 1400°F. will immediately limit the available list.

Following consideration of corrosion and heat resistance needs, selection proceeds to the physical and mechanical requirements of the design. If the corrosion problem is mild, the choice is simple; the many suitable stainless alloys offer almost any desired combination of mechanical properties. More severe service conditions may introduce the need for design ingenuity, if selection is restricted to one or two alloys.

Fabricability of the various stainless grades further limits selection. Proper alloy choice depends on how the part will be manufactured. Many stainless alloys are designed to afford specific fabricating advantages, hence a working knowledge of the available grades, as shown in Table I, will simplify selection.

The final criteria, of course, is economics. Tables II, III and IV show cost analysis of typical installations. Where a metal or alloy less costly than stainless will provide adequate service for designed life with the necessary safety factor, use of stainless is unnecessary. Additionally, in isolated instances, more highly alloyed materials must be considered under circumstances of exceptionally severe service. Large installations will profit through careful records that reflect such factors as installation and replacement cost, expected life, availability of material, and cost of fabrication.

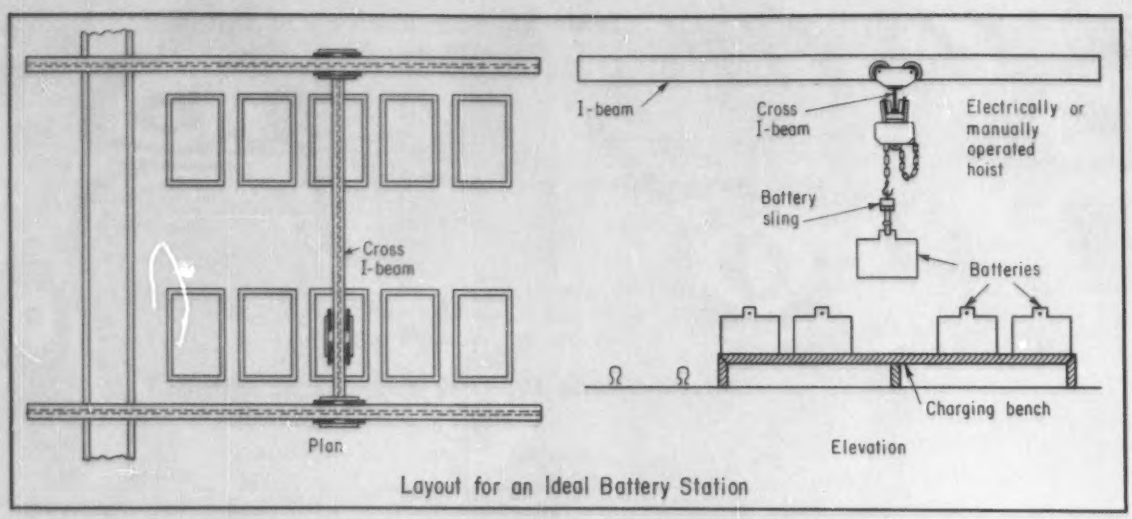


Fig. 1. Battery station layout includes sufficient spurs, switching facilities, adequate ventilation and a low re-handling rate. A simpler station is built with a single I-beam across the tracks and charging benches on either side.

The Battery Station—Mine Haulage Hub

WHEN LAYING OUT a battery charging area, room must be allowed so that batteries will be independently movable. Ideally, sufficient spurs and switching facilities should be provided so that every battery can be set up for charging and removal without having to move others (Fig. 1).

A second consideration in planning the station is to have a constant flow of active fresh air. Dependable ventilation in the station is necessary to keep ambient temperature down and remove dangerous gases. When ambient temperatures are excessive and battery temperatures rise above 110° F, battery life is needlessly shortened. If dead-end charging stopes are necessary, liberal use of fans and ducting is suggested.

Battery charging, maintenance and testing are facilitated by following standard practices recommended by the leading battery manufacturers.

Practical application of good layout principles and efficient charge room operation is indicated by practice at Magnet Cove Barium Corp.'s Arkansas barite mine.

At Magcobar, the battery charge room is located at the end of a heading and since headroom in the area is 7½ ft. lifting battery trays out of the locomotive is impractical. Parallel spurs have been laid, each long enough to accommodate two locomotives with the motor-generator charging and control equipment immediately beyond. Steel channel change-over racks are installed for receiving steel roller disks at the outer edge of each battery case as shown in Fig. 2. Magcobar has also designed a dolly for taking batteries on and off the change-over racks so a locomotive chassis will not be permanently tied up. Three batteries can be kept in the charging station while the other three are at work in the haulage drift. The two batteries nearest the charging equipment are usually on charge, and the battery nearest the switch in the track is always on a locomotive chassis, fully charged.

Magcobar's 24-in. gage locomotives are powered by six Gould-National locomotive batteries per chassis. Each battery is composed of 14 trays of six cells each. Each cell consists of 17 plates having a capacity of 440 amp-hr.

The charging area is ventilated by a 16-in. blower equipped with a canvas duct air conveyor which moves air to the rear of the battery station. Power comes to the charging area at 480 v, transformed down from the 2300-v primaries. Distilled water is brought into the mine in five-gallon jugs.

The mine water is mildly acid (pH 4 to 5) and corrugated roofing in the battery charging area is particularly important. Since 1952, roofing has consisted of heavily pitched corrugated galvanized iron as seen in Fig. 2, with the treated side against the roof of the drift. Roof repairs are easily made by adding a new corrugated sheet when needed.

Tungsten Mining Corp.'s, Henderson, N. C. mine has enough head room to lift batteries vertically. They use a simple, inexpensive monorail system with two Yale & Towne Pul-Lifts to move batteries on and off mine trammers for charging.

The lifts are attached to plain trolleys on the monorail and are fitted with double-hook chain slings. When the trammers are pulled up next to the charging table, the lifts are rolled out on the monorail to a position right over the battery. After the slings are attached, the battery is raised and moved laterally onto the charging station. Charge batteries are replaced in a reverse manner.

Preparing the Battery

Manufacturers recommend that battery users follow standard practices:

1. Batteries are shipped fully charged with electrolyte in the cells.

a. Keep battery right side up and unpack it carefully.

b. Examine for loss of electrolyte during shipment. Remove vent plugs and note height of electrolyte in each cell.

c. Restore electrolyte level by adding approved sulphuric acid of the same specific gravity as is in the other cells.

d. If no acid is on hand and the loss of electrolyte is small, restore the level of the low cells by transferring a small amount from each of the normal level cells.

2. Lift batteries vertically, using

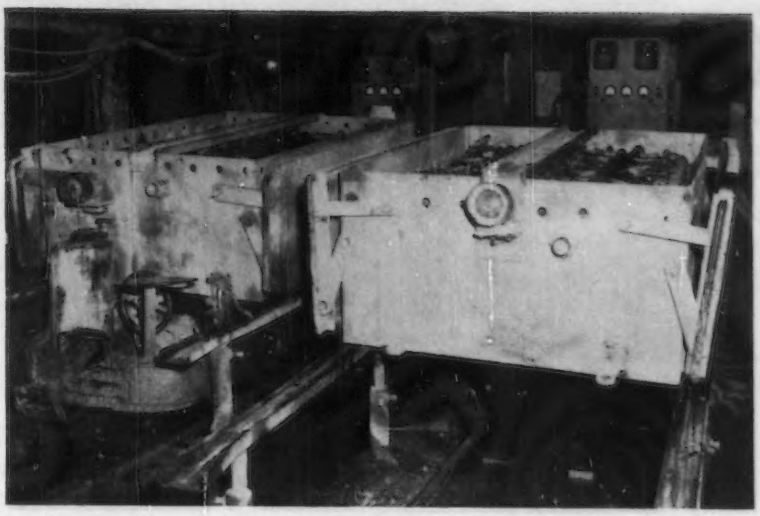


Fig. 2. Mine locomotives enter the change-over racks in the Macobar charging station. The batteries slide up inclined rails on steel roller-disks on case.

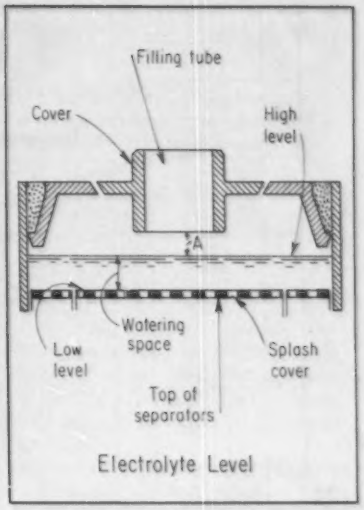


Fig. 3. Water is added to raise the electrolyte level within range of "A".

the handles, lifting eyes or lifting device provided.

a. With batteries assembled in steel trays, any lifting device used should employ a spreader of the exact length of the tray.

b. If a metal spreader bar is used, insulating links should be placed between the hooks and the bar.

3. Lost charge during transit should be made up.

a. If the specific gravity of the electrolyte is below 1.250, give a freshening charge. As long as the specific gravity of the lowest gravity cell shows any increase, the charge should be continued. Stop charge three hours after the last increase is shown.

b. When the freshening charge is complete, make a written record of the specific gravity of each cell and note the temperature and level of electrolyte in two or three cells for future comparison.

4. Battery compartment ventilation is a must.

a. Ventilation should be arranged so as to keep out water, oil, dirt and other foreign matter.

b. Drainage openings should be provided in the floor of the compartment.

5. Battery installation should be made in accordance with the manufacturer's layout sketch and should be firmly and evenly seated.

a. It is essential that the battery be properly blocked in the compartment to prevent excessive movement or shifting.

b. Clearance between battery and compartment walls or blocking should normally be about 3/16 to 1/8 in. on all sides. Do not wedge the battery in.

c. The blocking should merely be around the ends and sides of the trays and should not interfere with battery changes.

6. Connect batteries consisting of two or more trays with the positive terminal of one tray connected to the negative terminal of the next tray, throughout the system. Use inter-tray connectors supplied with the battery.

a. The positive terminals are painted red on top or are marked POS or +.

b. The negative terminals are painted black or are marked NEG or —.

c. Arrange connections so that the positive lead of the charging source will be connected to the positive terminal of the battery and the negative lead to the negative terminal of the battery.

d. Test the charging cable for positive and negative polarity with a voltmeter.

7. Clean and grease any surfaces which are to be bolted together. Use pure vaseline or grease, which also should be applied to the bolt studs before making the connection.

a. A soft wire brush should be used for cleaning lead-plated connections.

b. After all connections have been securely tightened, they should be gone over again a second time.

c. All connections must be wiped off with a clean cloth to remove surplus grease. Only a thin film is needed to accomplish the desired purpose.

8. Approved or distilled water should be added to all cells of the battery at sufficiently frequent intervals to keep the electrolyte level above the top of the splash cover.

a. When adding water, do not fill higher than shown in Fig. 3. The dimension "A" in Fig. 3 indicates the high level or the maximum height to which water should be added for each type of battery.

b. Water should not be transported in or stored in any metallic vessel, except lead. Glass, earthenware, plastic or rubber receptacles that have not been used for any other purpose are satisfactory.

c. During freezing weather, water is added just before the battery is placed on charge so that water will thoroughly mix with the electrolyte during charging and avoid the danger of freezing.

d. All cells of the battery should require the same amount of water. If one cell takes more water than the others, examine it for leakage.

9. The specific gravity of any lead storage battery lowers on discharge and rises again on charge. Gravity readings of the electrolyte in any one cell, known as a pilot cell, will indicate the state of discharge or charge of the battery as a whole.

a. Gravity readings in the pilot cell are taken by means of a hydrometer syringe.

b. After testing, always return all the electrolyte to the cell from which it was taken.

c. Both temperature and level of electrolyte affect the specific gravity and it is desirable to record the temperature and level of the pilot cell electrolyte at the same time as its gravity reading.

d. After adding water, a gravity reading should not be taken until the water has been mixed with the electrolyte by gassing (bubbling) of the

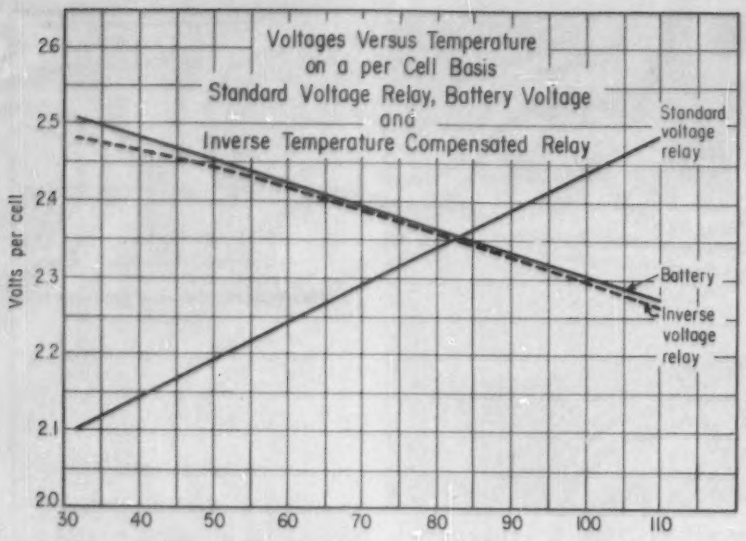


Fig. 4. A normal voltage relay increases its voltage operating point with temperature. Inverse temperature relays parallel the battery characteristic.

electrolyte on charging.

e. After reading the pilot cell about 50 times, change to a different cell for a pilot. Changing avoids lowering of the pilot cell gravity due to possible loss of small amounts of electrolyte each time the reading is made.

10. The specific gravity of a cell, when properly filled, should be about 1.275 to 1.295 for 47° F, 1.265 to 1.285 for 77° F and 1.255 to 1.275 for 107° F as recommended by Exide Industrial Div. of the Electric Storage Battery Co.

a. No harm will result if the battery is discharged to the full amount that it will give, provided that it is promptly and fully recharged.

b. Avoid over-discharge.

Adding the Charge

When charging storage batteries, the charge must be started and stopped. Starting is simple, the receptacle is connected to the generator or rectifier and the button or switch is actuated to start the charge. Stopping the charge at the correct time is more complicated. If the charge is not stopped at a pre-determined time, overcharging and charging at an excessive rate will result. The temperature will rise beyond recommended limits, undesirable gassing will take place and the life of the battery will be reduced.

Three automatic methods of controlling the charge are commonly used:

1. Ampere-hour meter
2. Voltage-time relay
3. Mechanical timer

As the name indicates, the amp-hr meter shows at a glance the amp-hr put into or taken out of a battery. Meters of that type are used with every type of motive power battery. They not only indicate the state of charge of the battery but also terminate the charge automatically when the end of charge is reached.

The meter may be mounted either on the locomotive itself or on the control panel in the charging room. When mounted on the locomotive the meter shows the amount of electrical energy left in the battery, controls the regular charge and eliminates a lot of hydrometer work.

Amp-hr meters may also be used to regulate the equalizing charge. With the battery at full charge, the meter is turned back to give an additional 25% charge to the battery.

Amp-hr meters are equipped with an adjustable resistor which regulates the percentage overcharge given during each charge. When the resistor is set for too much overcharge, the battery is overcharged each time it receives a charge. That is undesirable and will eventually result in battery damage or failure.

On old charging circuits the meters were sometimes equipped with a "quick make" contact. In that type of circuit the contact in the amp-hr meter is normally open until the hand has reached zero at the end of the charge and the contacts close. When the meter is equipped with quick make contacts, the associated circuit breaker is closed manually and held in place by a latch. The circuit breaker is equipped with a coil, which is energized by the completion of the circuit when the contacts in the amp-hr meter make, releasing the latch, causing the circuit breaker to open, thus opening the charging circuit and stopping the charge.

If there should be an open circuit in the wiring between the meter and the circuit breaker, or if the contacts of the meter are dirty and do not make good contact, the battery remains on charge, even though the meter hand is at zero.

On the front of the meter is a name plate. One item given on the name plate is the ampere capacity of the shunt associated with the meter. The other item indicated is the "amp-second" design constant for one revolution of the disk.

Using the above information to check a meter for accuracy, the operator must determine the number of amperes in the circuit and time the number of revolutions of the disk. He will use either 10 or 20 revolutions and observe the number of seconds it takes to make that number of revolutions. The following formula is used to determine if the meter is calibrated accurately on discharge or how much slower it is recording on recharge.

$$\frac{\text{Amperes (in circuit)} \times \text{Time (in seconds for number of revolutions)}}{\text{Ampere second constant} \times \text{Number of revolutions}}$$

Usually amp-hr meters are checked during recharge. The percentage overcharge setting of the meter is noted and then from the above formula it is determined how closely the meter is actually recording. Amp-hr meters are designed to record very accurately with current rates down to 10% of the shunt rated capacity. Amp-hr meters are often checked for accuracy during the period of high-rate charge and then later on checked during the period of low-rate charge.

It may be found that there is a 1 to 2% difference between the two readings which is of no consequence. When making the check, it is very important that the number of seconds be determined as accurately as possible. That is why 10 or 20 revolutions of the disk should be used instead of only one.

Review the Problem

Before discussing the voltage time relay method of control, a review of the characteristics of the voltage relay and battery voltage as it varies with temperature is desirable. A normal voltage relay has the characteristic of increasing its voltage operating point as the temperature increases. In Fig. 4, the increase in voltage with temperature has been converted back to a per cell basis. Reason for the increase is that the resistance of cop-

per wire increases with temperature. Therefore, the increase in temperature of the copper winding automatically increases the resistance of the coil, which results in less current flowing at a given voltage, reducing the magnetism at the pole face.

It is characteristic of a lead-acid battery that its counter emf or voltage on charge when in a fully charged condition decreases as the temperature goes up. Note that these two lines in Fig. 4 show why it is not practical to use a normal voltage relay in storage battery charging work.

Compensate by Relays

Inverse temperature-compensated relays are available. They are designed to change their voltage operating point automatically as the temperature changes, endeavoring to duplicate the voltage characteristic of a battery. The broken line in Fig. 4 shows the voltage operating point of an inverse temperature-compensated relay known as the TVR. Note how closely it follows the battery characteristic.

When the voltage operating point of inverse temperature-compensated relay is checked, it will be necessary to take the temperature of the relay into consideration. In motive power work a voltage of 2.37 v per cell at 77° F is standard. As the curve indicates, when the temperature is about 77° F, the voltage operating point of the relay will be less. The correction factor to use is .0033 per degree F. If the temperature is above 77° F, the voltage value is reduced from the standard and when the temperature is below 77° F, the voltage value is added to the standard reference value.

The TVR relay and other inverse temperature-compensated relays in motive power battery service are designed for operation at 2.37 v per cell at 77° F.

The amount of charge in ampere-hours required after a battery reaches the gassing point will vary depending upon how high the start-charge rate was and the extent of taper. In general, a battery is approximately 80% charged when it starts to gas and the rapid rise in voltage occurs. On that basis, an additional 2½-to 4-hr charge will be required to fully charge the battery.

Relay timing mechanisms are adjustable so that the time period at the end of charge may be set for any value from one to six hours. It is to be expected that the proper setting of the timer will vary between installations and between new and old batteries. The proper timer setting is that which just returns the battery to a charge without overcharging.

Whether there is overcharging can be checked by making a number of specific gravity observations at the end of the regular charge. First, the specific gravity of the pilot cell at the end of an equalizing charge is recorded. Next, the specific gravity of that cell at the end of a regular charge is checked and if the specific gravity is the same as obtained on the equalizing charge, the timer setting is cut by one-half hour. This method of checking is continued until it is found that the specific gravity at the end of the regular charge is slightly under that obtained on the equalizing charge. If the specific gravity was more than 10 points under, the timer setting should be increased by one-quarter hour.

It must be remembered that the device makes use of both electrical and mechanical units and that its object is to automatically control or stop a charge. Any automatic equipment is automatic but not fool-proof and good judgment and periodic checks must be made to determine that the equipment is operating correctly.

When using the inverse temperature-compensated voltage relay it is wise to observe these points: Don't place the relay where the temperature is considerably different than the battery location. For example, do not put the charging equipment in a heated room and the battery in an unheated place. Don't put the relay unit near the resistance in the back of the panel. The heat given off will affect the relay. Avoid vibrations in floor support which will cause the relay to operate prematurely. Watch for inoperative cells in a battery. One or more defective cells will permit the charge to continue indefinitely. Check the operation of the time clock. If it doesn't start when the relay starts, the charge will again continue indefinitely. Keep unauthorized persons away from charging equipment and relays. Don't permit tampering.

Turn Back the Timer

When using the time-voltage relay, the equalizing charge is given by turning back the timer or starting the charge over again after it has been automatically terminated. That results in an additional 2½-or 3-hour charge, depending upon the timer setting.

Very often with the mechanical timer method the low rate has considerable taper and the end of charge will be well under published finishing rate. That is a satisfactory condition because it reduces the amount of overcharging when the timer is set for a greater number of hours charge than required. Manufacturers usually furnish a specific gravity time-chart which is used to determine the setting of the timer for the charge, depending upon how much the battery was discharged.

To give an equalizing charge with that type of control, it is necessary to add three hours to the normal timer setting.

If a battery is to be put into storage, an equalizing charge should be given and water added to the cells during the charge. The procedure insures that gassing will cause thorough mixing and prevent freezing in cold weather. Add enough water to raise the level as shown in Fig. 3. After charging, all fuses should be removed to prevent use of the battery during the idle period. All vent plugs should be in place.

At certain periods the battery should be reconnected, water added, and the battery charged. Recommended periods are every two months in climates averaging 70° to 80° F and every six months in climates averaging 40° F.

Troubleshooting a Battery

Uniformity in voltage and specific gravity readings, especially near the end of the charge, can generally be accepted as an indication that the battery is in a healthy condition.

Battery or individual cell voltage readings can be taken with any good voltmeter of adequate voltage range. However, instruments under 100 ohms per v are usually considered unsatisfactory. Open circuit voltage readings will vary considerably, depending upon the specific gravity.

Internal trouble will lower the open circuit voltage readings of a cell and the readings will not compare favorably with the good cells in the same battery.

The relation between stabilized open circuit voltage readings and fully charged specific gravity is shown in Fig. 5. Open circuit voltage readings are affected very slightly by temperature and practically no correction is needed when normal battery operating temperatures are considered.

Experience has shown that a difference of 0.05 v between cells in the same battery on open circuit is sufficient to indicate possible internal trouble in the low-reading cells. A difference of 0.07 v on open circuit warrants an internal inspection. However, low voltages on open circuits can also be caused from lost electrolyte, and it is usually desirable to secure fully charged readings before arriving at a decision.

Fully-charged cells in the same battery on charge at the finishing rate should have uniform voltages. Any cell reading 0.10 v below the other

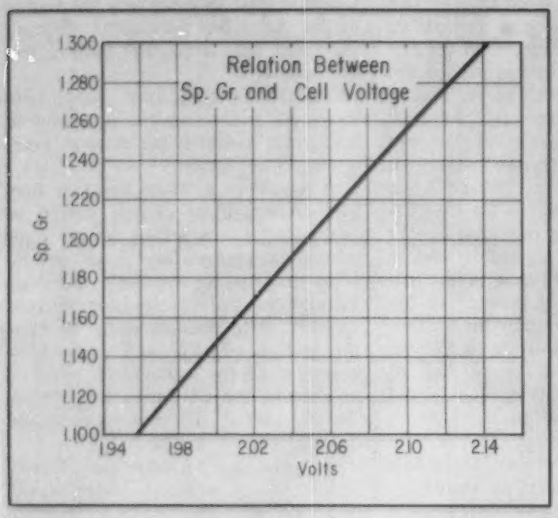


Fig. 5. Open circuit voltage is little affected by temperature and practically no correction is needed for reading.

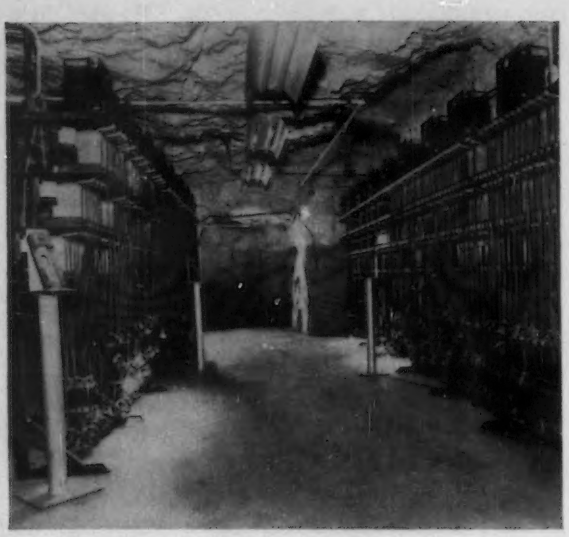


Fig. 6. New Jersey Zinc's Eagle Mine located a cap-lamp room on the 16 level for "convenience, economy and speed."

cells warrants further tests with a cadmium electrode to determine the nature of the trouble.

When trouble shooting, reports C & D Batteries, Inc., a cadmium electrode can spot problems rapidly and with little extra labor. The cadmium electrode is usually cast in stick form and normally is made in such a fashion that it can be readily immersed in the electrolyte of the cell and held suspended with a suitable handle while being electrically connected through a flexible wire to a voltmeter of proper range to measure single cell voltages.

When preparing to use a new cadmium electrode, it should be soaked in sulphuric acid for several days until the surface becomes corroded. It can then be removed and kept in a dry state until needed. The cadmium must be resoaked for at least one-quarter hour before reliable readings can be taken. Always agitate the electrode to keep gas bubbles from forming which interfere with accuracy.

Cadmium readings indicate the plate potential with relation to the electrolyte. The cadmium electrode is held suspended in the electrolyte and connected to the negative post of the voltmeter with the positive post connected through a suitable lead and probe to the positive terminal of the cell. The resultant reading is known as the positive cadmium reading. Cadmium readings are useful for general trouble shooting when taken at the end of charge, at or near the normal finishing rate.

Below is a representative sample of readings taken from a normal healthy cell on charge at the finishing rate and in a fully charged condition under normal temperatures (70° to 85° F):

Positive cadmium	2.43
Negative cadmium	—0.20
Terminal volts	2.63

The negative cadmium reading has gone into the reverse or the minus direction, which is normal.

If the meter used to read the negative cadmium on charge is not equipped with a minus scale, it will be necessary to reverse the leads on the voltmeter so the cadmium electrode is on the positive and the negative lead on the negative terminal of the cell. When the negative cadmium reading is in the minus direction, it can be added to the positive cadmium reading to secure the high terminal voltage.

Positive cadmium readings taken under fully charged conditions at the finishing rate will always be uniform in a normal battery. If the positive cadmium readings are more than 0.05 v lower than the surrounding cells, it is sufficient reason to make an internal inspection.

Cadmium Electrode Spots Trouble

Cell No.	Term. voltage	Pos. Cd.	Neg. Cd.	Specific gravity	Temp.
1	2.60	2.43	−.17	1.280	77° F.
2	2.60	2.42	−.18	1.280	77° F.
3	2.60	2.42	−.18	1.280	77° F.
4	2.33	2.35	+.02	1.200	77° F.
5	2.45	2.42	−.03	1.265	77° F.
6	2.60	2.42	−.18	1.280	77° F.

The table shows a series of readings taken on a six cell battery. Cell No. 4 has a relatively low terminal voltage which in itself indicates possible internal trouble. The positive cadmium is considerably below normal, leaving little doubt that the trouble exists. The cell should be opened and examined for internal shunts, such as a broken separator.

Cell No. 5 also indicates low terminal voltage. However, the cadmium check shows normal; therefore, the low voltage is being caused by something other than an internal shunt. Because the negative cadmium is not normal, it indicates that the negative plates are at fault.

This condition is usually caused by overdischarging. However, it could be the direct result of a leaking container or overflushing, as lost acid can result in overdischarging. It is especially true if the discharge cycle is deep.

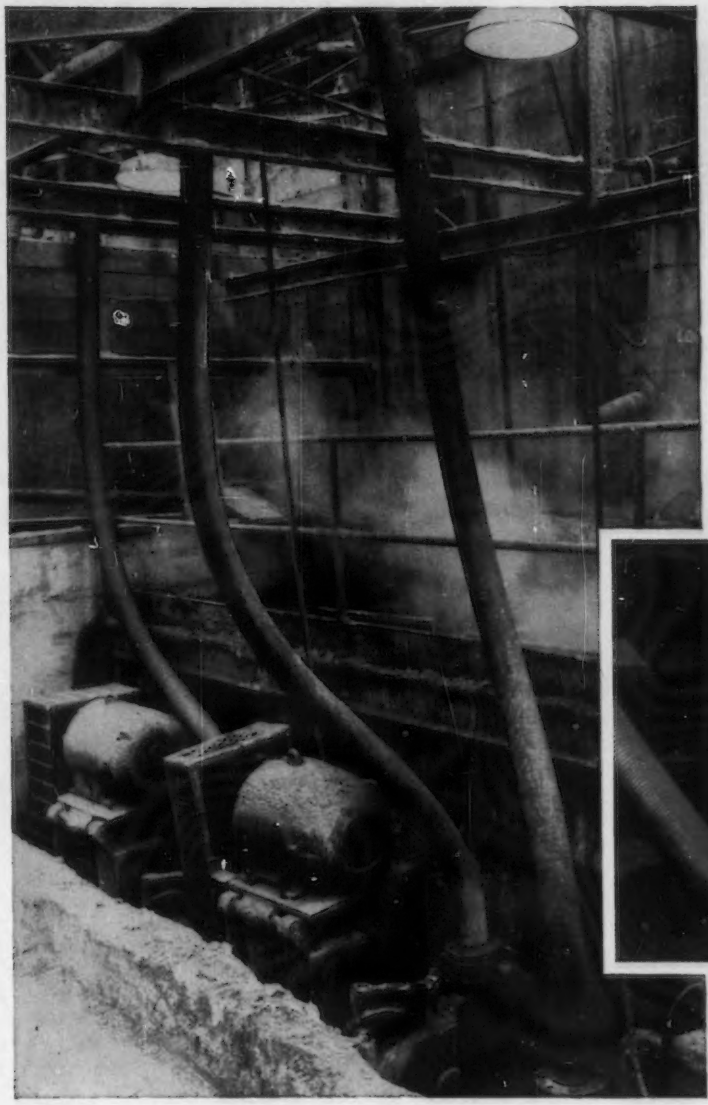
Cap Lamps Stay Underground

The New Jersey Zinc Co. makes use of an underground battery station not only for mine locomotive batteries, but also for cap lamps. The company's Eagle mine, Gilman, Colo. copper-silver producer 112 miles west of Denver, has an underground cap-lamp charging and repair room located on the 16 level—427 ft below the No. 1 shaft collar (Fig. 6).

The installation houses 475 M-S-A Edison R-4 electric cap lamps and 10 R-4 trip lamps. The equipment is used by approximately 125 men on each shift. In addition, on the day shift, miscellaneous mine crews, electricians, shop men and supervisors use the cap lamps, which are produced by Mine Safety Appliances Co. of Pittsburgh.

W. L. Jude, general superintendent of the Empire Zinc Div., said the 15x40-ft cap-lamp room is located underground "for convenience, economy, and maximum efficiency."

US RUBBER PILOT PIPE



Abrasion in piping?

Here's how a big uranium mill solved it with "U.S." flexible rubber pipe

• Four 8" U. S. Pilot Pipes carry fine screened ore from secondary crusher storage bins. Four more pipes feed too-coarsely crushed aggregate onto a conveyor belt and back into the crusher. On both jobs, Pilot Pipe has lasted over 4 years.

• In this severe service, quenched calcined ore pulp —50% solid—is pumped through these lengths of U. S. Pilot Pipe, from the roaster calcine pumps.

Where to get flexible piping that can stand up to severe abrasion without being chewed up?

Union Carbide's Uravan mill found the answer in U. S. Pilot® Pipe and Pinch Valves. In addition to the operations pictured above, these products handle the slurry on the 9 separate pumping stations of the counter-current decantation wash circuit, are used on the 2 booster stations between leach and tailings disposal plants and between the primary acid leach and roaster.

This pipe is specially built to handle abrasive materials, such as calcined ore, *and corrosive* materials, such as solutions containing sulfuric and hydrochloric acids. It is flexible, easy to install and won't build up. Its service life is longer than that of metal pipe.

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Mining Practice, Processes & Patents

A roundup on what's being written and said, the patents granted, the techniques tried in the mines, mills and smelters.

One Man Operates Two-Drill Jumbo

WHEN DRILL JUMBOS were installed in U.S. Potash Co.'s Carlsbad, N.M., mine years ago they were fitted two to a tractor and arranged so that two operators were required. To cut mining costs, U.S. Potash engineers redesigned the unit to put the controls in the center of the panel board so that one operaor can control the two drills easily. E. Lloyd Upton is shown here seated at the controls. According to the USP PIONEER, the changeover was made in the underground shop.

Traversing Pyrometer Checks Hot Spots

WHAT HAS BEEN for years considered a normal operating hazard is a thing of the past at Universal Atlas Cement Div. U.S. Steel Corp.'s Buffington Harbor, Gary, Ind. plant. For years cement plants operators suffered the bugabear of hot spots and damaged kiln refractories until a traversing pyrometer was designed and installed in 1958. The pyrometer is a Minneapolis-Honeywell Radiamatic unit with ±2½% accuracy in the 520° to 970° F range and is suspended on a cable that is geared to traverse the length of the kiln.

When the pyrometer detects a hot spot (temperature still below spalling point of refractory), it sounds an alarm, marks the spot in the kiln on an Electronik recorder and stops on the spot to show the operator where the trouble is. In the first six months of operation, the kiln was down once for repairs; in nine months the year before without the detector, the kiln was down five times, according to INSTRUMENTATION, Vol 12, No. 4, July-August 1959, pp 8-9.

Leaching Upgrades Nevada Palisades Iron Ore

AN INVESTIGATION to find a way of reducing the phosphorus content of an extensive iron deposit located near Palisades, Eureka County, Nev. shows that the phosphorus content can be cut below the 0.3% P maximum desired by the industry. Flotation was successful; so was magnetic separation. However HCl leaching proved to be the best in regards phosphorus elimination and iron yield. Ore runs about 60.7% Fe, 0.56% P and 0.03% S.

According to A. L. Engel, and H. J. Heinen in U.S. Bureau of Mines REPORT OF INVESTIGATION 5449, "Experiments in Reducing the Phosphorus Content of a Nevada Iron Ore", the ore is a massive red hematite, paramagnetic in part, with silica, alumina and an unidentified phosphate mineral as a fine network or seam in the hematite and friable parts of the ore. Magnetic separation produced a concentrate at minus 10 mesh that assays about 65.65% Fe and 0.42% P at 35.9% Fe recovery in the magnetic fraction. A minus 48 mesh sample was tried and produced a magnetic concentrate grading 65.11% Fe, 0.26% P at 53.7% Fe recovery.

Flotation tests at minus 48 mesh produced concentrates grading 61.8% Fe and 0.29% P. Iron recovery was 95.5%. A sample floated at minus 65 mesh yielded a concentrate grading 61.21% Fe and 0.28% P at 92.4% Fe recovery.

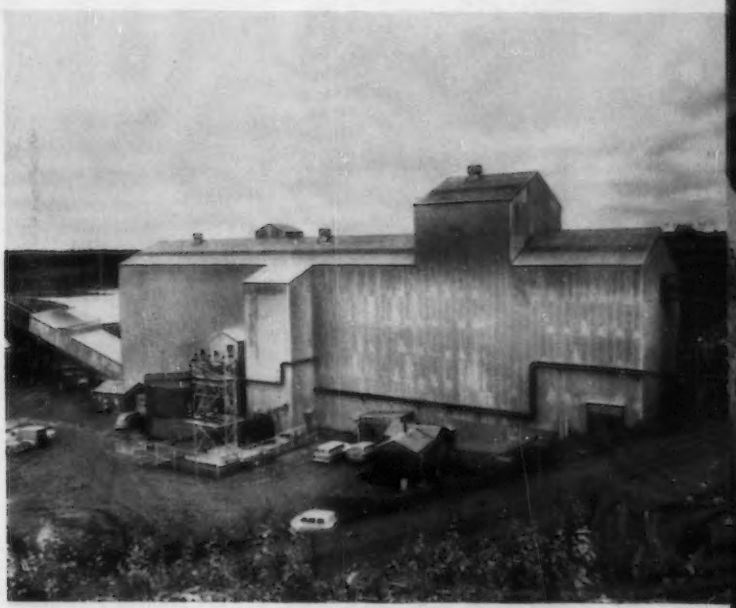
Tests by leaching with 5% HCl produced a 61.91% Fe and 0.27% P at 99.97% Fe recovery.

To cut the cost of treating the ore, the authors experimented with grind and time, and settled on minus 10 mesh, 2½% HCl, and six hours as most economical conditions. A further test to cut cost by using H_2SO_4 resulted in a 61.62% Fe, 0.25% P at 99.91% Fe recovery; but the sulphur content went up from 0.03% to 0.08% S—a decided detriment to the iron master. The authors suggested the production of gypsum as the cause and the data shows that 75% of the sulphur is contained in the minus 10 plus 20 mesh fraction (53.8% of product).

Japanese Test Ryusei Uranium Ores

URANIUM-BEARING ORE—high in soluble iron and copper —from the Ryusei pit, Matsuiva mine, Miyagi Prefecture, Japan were tested in a series of leaching experiments by Kingo Sudo and Akiichi Kigoshi. The ore assays about 0.08% U_3O_8, 17% Fe, 0.95% Cu, 4% S, 18% Al_2O_3 and 52% SiO_2. According to their published work in SCIENCE REPORTS of Tohoku University Research Institute, Series A, Vol. II, No. 4, August 1959, acid leaching with dilute sulphuric acid under atmospheric oxidation proved to be the most effective method, recovering some of the copper, a little iron and over 96% of the uranium. Results with nitric acid were somewhat lower, even though oxygen was used as an oxidizer; only about 80% recovery. Carbonate leaching, preroasting and pressure leaching were not of any value in the tests.

"Imagination... is the source of human improvement; experience its implement"



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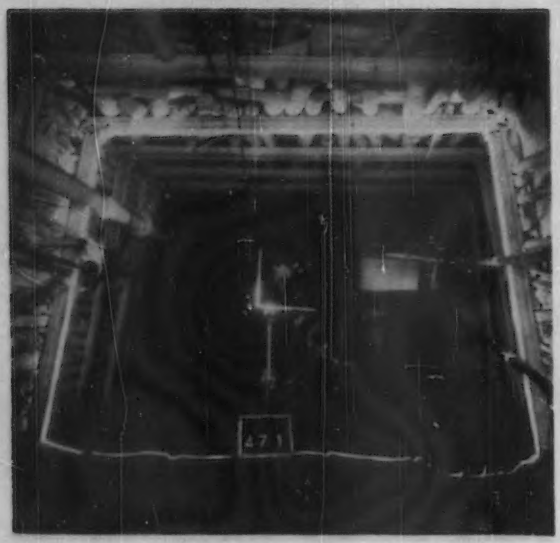

Light and Camera Measure Mine Profiles

PHOTOGRAPHS of a plane of light projected on the walls of underground galleries are the key to a fast method of taking profiles developed by Charbonnages de France, the national French coal authority. Accuracy of the photographed cross-sections, the authority says, is comparable to profiles obtained by direct measurements.

Equipment required for the method, known as Photoprofil, consists essentially of a special projector and a standard commercial camera (usually a 2¼ x 2¼-in. reflex type). In the projector, a standard Oldham-Arras mine lamp is used as a light source; the lamp (rated 2.5 vs. 2 amps) is operated at a higher voltage to obtain a more actinic light. The light is projected through 360° in a plane by means of a Fresnel ring in plexiglas about 7-in. dia. The projector also includes two scales, tubes of aluminum 50 cm long, one horizontal and vertical, located in the illuminated plane.

Operation of the equipment is simple. The projector unit, mounted on a standard tripod, is centered by eye at the station where the profile is taken. For an extremely accurate profile, the projector is leveled to make sure that the illuminated plane is absolutely vertical. The camera is then set up with its objective at the same height as the reference target on the projector at a station where the entire illuminated cross-section appears in the camera's viewing glass. The profile is then photographed. In a gallery of about 100 sq ft cross-section, using Kodak Tri-X film, an exposure of 10 sec is required with the lens at f 4.5.

Area of the profile cross-section is determined by projecting the negative on the board of a photographic enlarger and then using a planimeter. Scale is established by the apparent dimensions of the 50 cm aluminum tubes in the projection. Negatives are identified by placing a board with station number and date in the illuminated plane when the profile is shot.

Developed by the research laboratory of Charbonnages de France, the Photoprofil equipment is manufactured by Ets Barbier-Bernard et Turenne, 82 rue Curial, Paris 19°, France.

Phosphate Rock Slags Garnierite

NORMALLY, garnierite—the nickel magnesium silicate—is slagged with silica, limestone and gypsum to produce nickel matte; not so in the latest development from Japan, according to a bylined article by Jumpei Ando, Chuo University, Tokyo, Japan in the October 1959 issue of INDUSTRIAL & ENGINEERING CHEMISTRY pp 1267-1270. Novel method substitutes phosphate rock for the limestone, and produces a phosphate fertilizer and nickel matte. In the process, fully documented in the article, garnierite is sintered with phosphate rock, then with gypsum and silica, and finally smelted in a blast furnace. While the smelting step is inherently more difficult than the conventional limestone method and while almost all the ingredients used in the process must be imported into Japan, several Japanese companies are reportedly switching to the method to gain the advantage of the fertilizer production. Japanese imports most of her mineral fertilizer.

Television Helps Kiln Operators

AT IDEAL CEMENT CO.'s new plant in Houston, Texas, two 12-ft dia by 450-ft wet process cement kilns are watched, regulated and controlled with the aid of closed circuit television cameras and screens. The camera is a Model 300 Utiliscope equipped with an auxiliary cooling source to protect it against the nearly 2100° F of the kiln's interior. The cameras report the conditions within the kiln to two 17-in. screen monitors set up in an air conditioned control room adjacent to the kiln floor, according to Diamond Power Specialty Corp. which supplied the system and equipment used by Ideal Cement.

Diathermic Separation—Parting Minerals on the Basis of Heat Absorbing Ability

A MAJOR technological breakthrough in research to find a new and practical method for upgrading rock salt has been announced by International Salt Co., major domestic salt producer. The breakthrough, which involves an entirely new method for improving the quality and appearance of rock salt by separating it from its impurities, answers a long standing problem.

Announcement of the new upgrading method was made as the U.S. Patent Office issued Patent No. 2,907,456 covering the basic process as applied to rock salt and other materials, and assigned to the International Salt Co., Inc. International Salt is planning to license the process for materials other than salt.

The new method is simple in principle and low in cost. It consists of two main steps: selective heating by radiation, and separation of the heated particles by a heat-sensitive surface. Neither of the steps has previously been used commercially.

Based upon diathermic separation (ability of materials to transmit heat), the new process takes advantages of the different heat-absorbing properties of rock salt, and anhydrite, dolemite and shale. Sodium chloride crystals are transparent to infrared heat waves (diathermanous),

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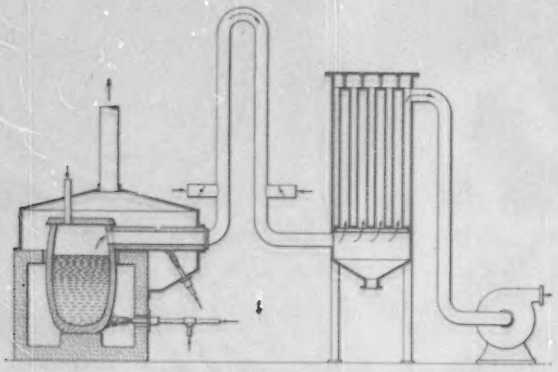
Ford Process Uses Molten Metal as Solvent

A CYCLONE burner operated under reducing conditions is used to contact a molten wash metal and a mixture of molten smelter charge in a patent granted to Ford Motor Co. of Canada, Ltd.'s T. H. Oster (Canadian No. 578,966 and 579,350). Depending on metal being smelted, a wash metal with solvent affinity for the desired metal is used. Example given in patent uses molten lead or cast iron to extract copper from copper ores or Sudbury nickel ores.



Fuming Germanium From Zinc Residues

GERMANIUM occurring in zinc concentrates is thrown down with the copper and arsenic in purification of the electrolytic solution, and is difficult to concentrate and recover. However, American Smelting & Refining Co.'s Yurii E. Lebedeff and William H. Wetherill have described a smelting operation in which substantially all the germanium is fumed from the copper in the presence of excess sulphur. The sulphur reacts with the copper to form matte and must be present in excess to prevent formation of metallic copper or speiss. Metallic copper or speiss will dissolve germanium up to 0.76 to 1.10% Ge while matte will hold only 0.017 to 0.042% Ge and slag, if any is formed in the furnace, will hold but 0.02 to 0.1% Ge. Patent No. 2,889,196 recommends a crucible furnace or a reverb, the burning of the fume with excess air to make it easier to collect in a baghouse or precipitator. Zinc and arsenic fume as well as the germanium and concentrate with it in the baghouse product.

French Explain O.L.P. Process

A METHOD OF REFINING PIG IRON by spraying crushed limestone and oxygen into the melt has been developed to a commercial stage in France. Metal obtained in the process has a very low phosphorus, sulphur and nitrogen content.

For a number of years, the Research Institute of the French Steel Industry (IRSID), an industry-wide organization, has concentrated on investigating the effects of injecting additions in powder form into the metallic bath and developed out of these investigations the "O.L.P. (Oxygen Lime Powder) Process". The injection in powder form produces an extremely rapid and intimate contact between the components of the converter charge, pursuing the same goal as the Perrin metallurgical process for the refining of metals by stirring with liquid slags.

In that same field of injecting powdered materials into a liquid bath, IRSID had previously developed industrial scale: The desulphurization of the molten pig iron through the injection of powdered lime in suspension in nitrogen or air; and the injection of powdered materials (lime and iron ore) through the bottom of the basic converter which shortens the blowing time and produces high quality steel.

Following the same line of thought, IRSID had been carrying out investigation on the possibility of blowing, onto the surface of the melt, powdered lime suspended in a jet of pure oxygen. Numerous detailed tests at small scale with powdered lime or a mixture of powdered lime and iron ore demonstrated the advantages of the new process. Experimental operation on a pilot scale of three tons in a mill in the east of France rapidly confirmed the considerable advantages in industrial operation.

Thanks to the experience acquired both during the preliminary investigations as well as during the industrial development of other IRSID processes utilizing injection in powder form, the industrial application of the new method at the Denain plant of Societe Usinor was remarkably simple.

The process may be defined as a method of converting pig iron in a stationary vessel by blowing powdered lime in an oxygen jet on the surface of the melt. It differs radically from other converting methods by a complete change in the action of the oxygen jet which strikes the surface of the melt.

The converter has a solid bottom. The one used at the Denain plant is a basic converter in which the bottom with tuyeres has been replaced by a solid bottom. Equipped with the ordinary tarred dolomite lining, the converter has an inside diameter of 8½ ft at bath level and a total capacity of 880 cu ft, or 28 cu ft per ton of pig iron.

An injection lance, with a copper tip which is abundantly water-cooled (7,926 U.S. gal per hour) projects vertically over the surface of the melt and can be adjusted laterally and vertically, either to remove it from the converter or to adjust the distance of the nozzle from the surface of the melt during operation.

A dry lime feeder accurately and uniformly injects a given amount of powdered lime into the oxygen stream, the concentration depending upon the pig iron composition, the phase of refining and the type of steel desired.

The pig iron used comes, as usual, from a mixer or from ladles. The O.L.P. process can be applied equally successfully to all types of pig iron.

The lime used is a commercial grade for steel mills whose composition, aspect and degree of calcination may vary within large limits. Contrary to other steel making processes, in particular those employing pure oxygen, the O.L.P. process is not affected by such irregularities because it uses the lime in a finely pulverized state.

The lime may be pulverized at the steel mill by rotary crushers, equipped with 2-mm screens, which feed to the dispensers by means of a Fuller-Kinyon pump. It may also be ground directly at the kiln and delivered to the steel mill as a screened product in airtight containers unloaded by compressed air.

The oxygen used up to now at Denain comes from an installation furnishing 2.800 cfm of 99.5% commercial oxygen at a pressure of 210 psi. The blowing pressure is about 85 psi and the flowmeter controlling the converting operation is gaged for a maximum of 3,500 cfm. An assembly of recording instruments for pressure, flow and total quantity of oxygen furnishes the data necessary for controlling the refining operation.

The cooling additives consist either of scrap or iron ores, such as Swedish or Canadian ores.

The flexibility of the process makes it suitable for refining any type of pig iron and producing the desired grade of steel according to the FRENCH ECONOMIC & TECHNICAL BULLETIN.

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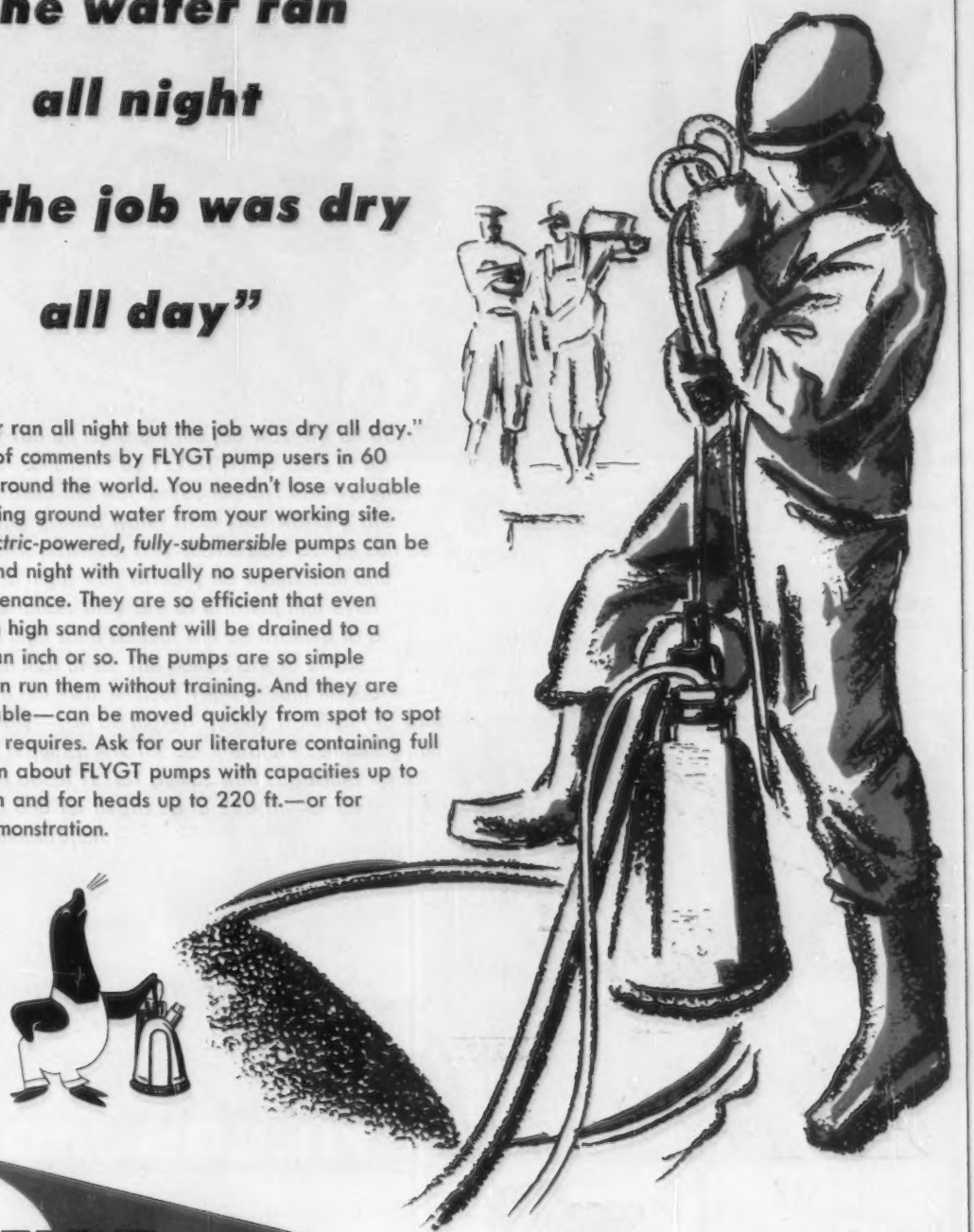

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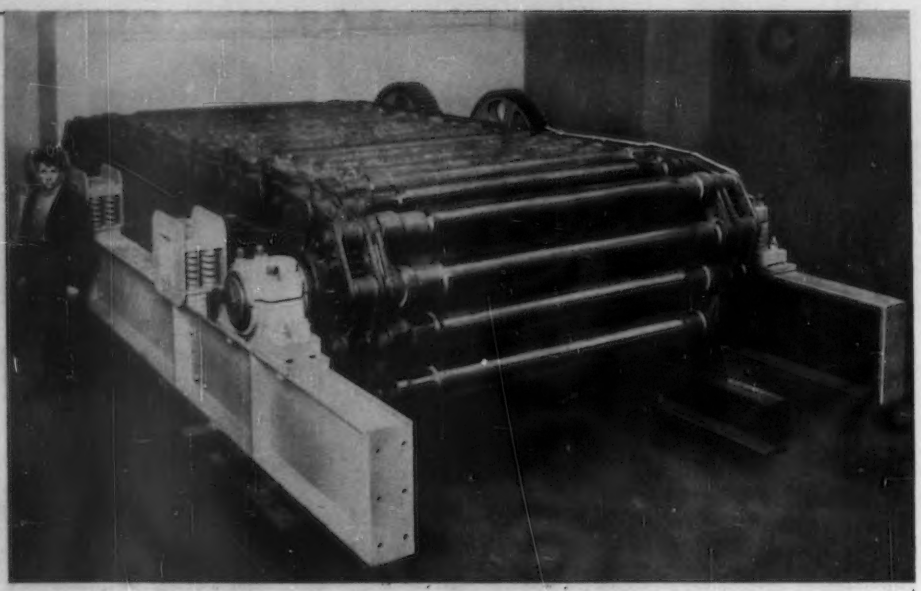

Photograph shows a No. 10 Ross Patent Drop-Bar Feeder assembled before despatch to Llanddulas Quarries for feeding a 60" x 42" Jaw Crusher. The photograph illustrates the very heavy construction of the apron, in this case 7" dia. steel bars at 10" centres and the heavy shock-absorbing coil springs which support the apron.

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Trademarks Reg. U.S. Pat. Off.

whereas the rock salt impurities absorb infrared heat (athermanous). When crushed rock salt is exposed to radiant heat, the impure pieces are selectively heated; the rock salt crystals remaining relatively cool.

A high-speed conveyor belt coated with a heat-sensitive resin does the actual separation of the rock salt from its impurities. After passing under infrared heat, the crude rock salt is slid onto the coated belt. The pure rock salt crystals, being relatively cool, fly off the end of the belt into a catch bin. The impurities, however, because they are warm, adhere to the belt just long enough to leave the end of the belt with less momentum and drop into a bin nearer to the end of the belt than the rock salt bin.

The first commercial unit was installed underground in the company's Detroit mine. It has proved that it can be expanded to unlimited capacity. At present, the unit is used only in the production of one size of salt in the mine. Its application to other sizes of Detroit mine salt, as well as to the company's other mines, is being studied carefully.

Besides its Detroit mine where development work on the new separation method was undertaken, International Salt also mines rock salt at Retsof, N. Y. (largest rock salt mine in the world), and at Avery Island, La. (oldest rock salt mine in North America). A new $11-million mine is now being completed at Cleveland, Ohio, and is expected to be in production by mid-1960. The company has evaporated salt refineries at Watkins Glen and Ludlowville, N. Y., and Avery Island.

Sheer-Korman Hierarc Process Data Released

HERE ARE the latest data on the Sheer-Korman high intensity arc process as presented by Victor Harris, John D. Holmgren, Samuel Korman and Charles Sheer of Vitro Laboratories Div., Vitro Corp. of America at the 1959 annual meeting of the Electrochemical Society (JOURNAL OF THE ELECTROCHEMICAL SOCIETY, October 1959, pp 874-6) Colorado rhodonite which contains 42% Mn was used in the experiments. The ore when mined and processed in connection with lead-zinc operations can be concentrated to 33 to 36% Mn. Yet the rather refractory silicate does not respond to any normal method of concentration to produce a satisfactory product. Vitro has been doing research on the rhodonite deposit using the Hierarc Process developed by Sheer and Korman. These data were obtained with rhodonite incorporated in a 2-in. dia electrode to the extent of 75 to 85% by weight of ore. The arc process vaporizes the electrode, decomposing the mineral to MnO and SiO_2 in very fine particulate form which is collected in a baghouse. After arcing, 95% of the manganese content of the product is soluble in dilute HCl at room temperatures.

Current used	700 amp
Power consumed	50 kw
Anode feed rate	103 in./hr or 24 lb/hr
Slag (unreacted electrode)	16.5% of total
Anode vaporized	20 lb/hr electrode
United power consumed	2.5 kwh/lb electrode vaporized
Production rate	13 lb/hr of arc product
Cathode consumption	0.5 lb/hr of graphite

Additional U.S. and Canadian Patents Briefly Noted

Patent information is provided E&MJ by Oliver E. North, patent consultant, Washington, D. C. Mr. North also scans and abstracts the patents issued in Canada and Great Britain which appear below and which will appear in forthcoming issues of E&MJ. U.S. patents may be obtained from the Commissioner of Patents, Washington 25, D. C. (25c each); British patents from the Patent Office, London; and Canadian from the Patent Office, Ottawa.

What's New in U.S. Patents

Scouring-crushing uranium ores to free values from cemented sand grains (A. T. Sweet) 2,906,465

Design for a vibrating table (G. Jean) 2,907,459

Hydraulic means of adjusting the crusher clearance on a gyratory crusher (L. R. MacLeod) 2,908,448

Method of applying a ceramic coating to solid objects. Process is called Flame Ceramics (Armour Research Foundation) 2,904,449

Apparatus for charging retorts in zinc furnaces. Tonnage over hand charging increases 35 to 50%. Patent covers four different constructions and may be used for material piling, trimming and bin filling. William G. Hegmann, licensed to Matthiessen & Hegeler Zinc Co., La Salle, Ill. 2,868,351

Grinding nozzle for producing metallic powders and oxides. Apparatus incorporates a unique means of subjecting a tubular stream of molten metal or a liquid to the action of two counter fluid blast streams. Discharge points lie in a single transverse plane, thus effecting instantaneous contact of the streams. Parts of the apparatus which contact the molten metal are made of electrocast refractory, permitting atomization of the higher melting point metals. William G. Hegmann, Matthiessen & Hegeler Zinc Co., La Salle, Ill. 2,868,587

These U.S. Patents Have Expired

Floating phosphate with fatty or resin acid and mahogany soap-fuel oil reagent (Phosphate Recovery Corp.) 2,303,931

Floating mica from feldspar or kaolin (Phosphate Recovery Corp.) 2,303,962

Reduction smelting of Bolivian cassiterite to volatilize tin. W. H. Osborn 2,304,197

Iodine treatment of gold-containing complexes to yield gold-iodine-amalgam. G. D. Harrison .. 2,304,823

Using a petroleum naphtha sludge derivative in cleaner flotation of a sulphide concentrate. C. L. Read 2,305,032

Floating kyanite (Phosphate Recovery Corp.) 2,305,502

Magnetic separation of iron from aplite or nepheline syenite. R. W. Lawson and W. F. Deneen .. 2,306,171

Canadian Patents Recently Released

Aluminum cell anode construction (Vereinigte Aluminium Werke) 582,489

Leaching iron from ilmenite (Tikkanen and Tholand) 582,549

Maintaining temperatures in an R-N kiln (O. Mokelbust, National Lead Co.) 582,553

Converting ilmeniet to rutile by HCI leach (E. Wainer, Horizons Inc.) 582,579

Cyclone Steel Process (British Iron & Steel Research) 583,323

Leaching vanadium from magnetite (Hoganasmetoder) 583,357

Improving copper deposition at the cathode with an acrylamide polymer hydrolyte in combination with glue or casein (R. J. Lapee, Anaconda Co.) 583,429

Process for making aluminum cell anodes of controlled composition (Pechiney) 583,671

Norsk-Staal Process variation of direct reduction 583,785

Improvements in the Krupp-Renn direct reduction process 583,795

Aspeco Oil Shale Process for reduction of iron ores .. 583,815

Leaching iron from ilmenite (R. D. Pike) 583,821

OPERATING IDEAS

Plastic Tubes Form Safety Device for Blasting Hung-Up Boxholes

PLASTIC TUBING is being put to work in more and more underground and surface operations. The latest scheme uses tubing as part of a safety device for blasting hung-up boxholes at the Creighton mine, International Nickel Company of Canada, Ltd. The following idea appeared on the last page of the April 1959 issue of INCO TRIANGLE, the company magazine.

At Creighton, the flow of ore in one of the 14 boxholes feeding into a slusher drift may become blocked as many as six times during a single shift. Each of these plugs must be blasted clear and, since there are more than 50 drifts in the Creighton caving area, a considerable amount of blasting must be done during a shift to maintain an even pull of ore.

Under the old method of preparing a blast in a hung-up boxhole, it was necessary to climb up in the boxhole and push the bags of powder into place on the end of a wooden pole. Sometimes the powder had to be placed as high as 50 ft up the boxhole.

After a good deal of experimenting, the engineers at Creighton's No. 3 shaft developed a light, rectangular tube, made in 10- and 20-ft sections with sleeve joints. The tube and sectional loading sticks were made of uscolite, which, aside from everything else, had a great safety feature—it did not absorb nitroglycerene.

Powder was especially packed in a cardboard carton which slid easily in the plastic tube and did not roll out of position when pushed up through the tube into the hung-up boxhole.

The blasting boss and slusherman can now remain standing in the drift and place the powder just where they want it in the jammed ore blocking the boxhole.

Old Belts Protect Road Surface

OLD CONVEYOR BELTING, which had previously been discarded by a mining firm at St. Genevieve, Mo., is now being used by it to protect the surface of a local county road.

An official of the Mississippi Lime Co. said that his firm's operations lie on either side of a black-top county road, across which crawler-type machinery must frequently travel. "Discarded conveyor belting which has been laid permanently across the road," he said, "prevents the crawler from damaging the pavement. However, the belting in no way interferes with normal road traffic."

New Scheme Speeds Inventorying

A NEW APPLICATION of the electronic computer, improved stereo-plotting and aerial photography have opened up a broad new field for faster, cheaper and more accurate inventorying of ore and other bulk material, according to Lockwood, Kessler & Bartlett, Inc., Syosset, N.Y.

Calling the method "a breakthrough in this often troublesome and expensive type of inventory work," president Ford Bartlett said that extensive testing "confirms our earlier experience on highway earthwork, and shows that we get more accurate results than can be obtained in conventional survey methods, with major savings in time, cost and labor."

The new procedure is proving particularly valuable, he pointed out, in keeping records of cubic yards of material removed from open pit or strip mining and similar operations where depletion affects contracts and taxes.

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When you compare specifications point by point, we are sure you will agree with all those who in recent months have specified DENVER over all other mills. You get

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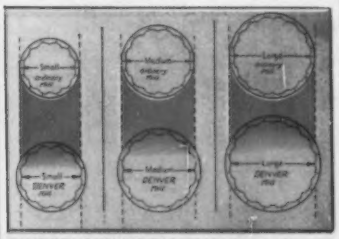
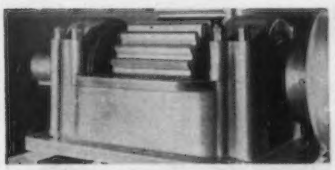
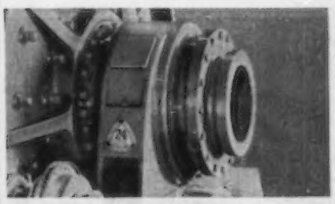


MORE CAPACITY—Working diameter is determined by measuring *inside* new liners—not inside the mill shell. You get more grinding capacity for your investment.



PINION BEARINGS are self-aligning, anti-friction type, in cartridge type carriers and mounted in one-piece housing which is bolted to adjustable trunnion sole plate for perfect, permanent alignment of gear and pinion.



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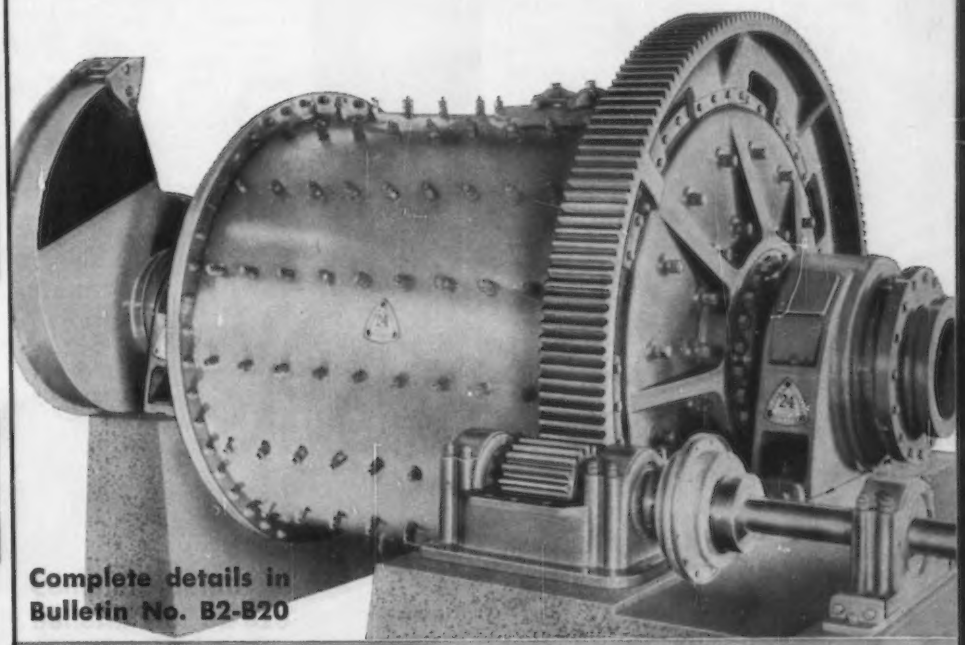
Send 25 or 50 lb. sample of material prepaid to Denver Testing Laboratory, 1755 Blake St., Denver, Colo., for your preliminary test.

There is no charge to you for this service and information from this test will help you in your decision.



Complete details in Bulletin No. B2-B20

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PERSONALS

John S. Brown, chief geologist, St. Joseph Lead Co., retired October 1 after 34 years of service. Starting at Joplin in 1925, Mr. Brown was transferred to northern New York (Edwards-Balmet) four years later, and assisted in bringing the area into prominence as a zinc center. In 1947 he was transferred again—to Bonne Terre as chief geologist. It was during this period that a sizable geological staff was created and important new discoveries were made; including Pea Ridge (iron) and Viburnum (lead).

Brown

George F. Reed has been appointed resident manager of Sonoma Quicksilver Mines, Inc. From 1953 to 1958, Reed was assistant general manager of Wah Chang Mining Corp., and, for the past year, has been consulting engineer for various mining companies operating in southwestern Nevada.

Karl A. Gardner has been appointed vice president in charge of engineering of Yuba Consolidated Industries, Inc., and **Charles L. Banks,** former Marine Corps Brigadier General, has been appointed assistant to the president.

Dr. Paul F. Genachte, director of the Chase Manhattan Bank's atomic energy division, has been elected a director of Homestake Mining Co., to succeed the late **Archibald A. Gulick.**

William N. Matheson is the new executive vice president of Oliver Iron Mining Div., according to **R. T. Elstad,** president of the U.S. Steel Mining division.

Matheson

At the time of his promotion, Mr. Matheson was Oliver's vice president in charge of operations. Since 1956 he has been responsible for the production of iron ores and concentrates from Oliver's mines and ore dressing plants.

Before being named Oliver's vice president in charge of operations, Matheson served as vice president (since 1953) in charge of sales and planning. He was then responsible for the sale and purchase of ores, lands, timber, mining supplies and the development of plans covering Oliver's many activities.

Thomas J. Ready, Jr., has been named executive vice president of Kaiser Aluminum & Chemical Corp.

Mr. Ready has been serving as vice president and assistant general manager in charge of aluminum operations. He became associated with the Kaiser organization in 1942 and served as assistant general sales manager and administrative assistant to the general manager of the Kaiser Co., Inc., iron and steel division.

When Kaiser Aluminum entered the industry in 1946, he joined it as assistant general manager, and was named a vice president in 1950.

Leo E. Read has been appointed general manager of International Salt Co.'s Detroit and Cleveland mines, according to an announcement by **Floyd G. Parrish,** director of production. At the same time, **John L. Ryon, Jr.** has been moved from the position of assistant manager to manager of the Detroit mine.

Read joined International in 1924 and supervised the completion of the Detroit mine's present production shaft. In 1945, he was appointed manager of the Detroit mine.

Ryon came to the company in 1949 as an engineer at the Watkins Glen, N.Y. refinery. He was appointed assistant manager of the Detroit mine in 1957.

Donald F. Ingvoldstad, former smelter chief research metallurgist, was recently promoted to assistant smelter superintendent for Bunker Hill.

Ingvoldstad

Ingvoldstad graduated from the University of Minnesota at a metallurgical engineer in 1935. He also holds a Master of Science degree in metallurgy from the University of Idaho.

He has been with Bunker Hill since 1936 and was a research metallurgist until 1954 when he became chief research metallurgist for the smelter.

Kennecott Refining Corp. has named **Ivor G. Pickering** as general manager of its new electrolytic refinery south of Baltimore. He had been project manager during the planning and construction phases of the new copper refining facility.

Pickering was employed by Kennecott in 1939 at the company's open pit copper mine near Salt Lake City. He joined the Western Mining Div.'s engineering department in 1954 and was promoted to chief design engineer in September 1955.

B. A. Robbins, assistant to the general manager at the Chino Mines Div., Kennecott Copper Corp., retired Nov. 1.

Robbins came to Chino in 1920 and worked at Hurley as day timekeeper, voucher and insurance clerk, mill superintendent's secretary, metallurgical accountant, general manager's secretary and division comptroller, before being appointed to his present post in 1956.

John P. Strand, formerly titanium division superintendent at the Crucible Steel Co.'s Midland works, has been appointed assistant director of the technical division in the company's technology department. He will be responsible for the product development sections.

Glenn C. Waterman, Salt Lake City, has been named chief geologist for Anaconda Co. of Canada, Ltd.

Waterman

Mr. Waterman worked for Idaho Maryland Mines Corp., Grass Valley, Calif., from 1934 to 1942; joined U.S. Smelting Refining & Mining Co., Bingham and Eureka districts, Utah, and returned to Grass Valley in 1945 to become chief engineer and geologist.

He joined Anaconda in 1947 to work as chief geologist in British Guiana until he was made chief geologist for Chile Exploration Co., an Anaconda affiliate, in 1951.

Since 1955, Mr. Waterman has been an exploration geologist, Salt Lake City.

A. Olaf Wolff is the new director of research and development for the Consolidated Mining & Smelting Co. of Canada Ltd. Formerly manager of the metal sales division, Wolff will co-ordinate the firm's technical research and development, market research and commercial development. He has been with Cominco since 1938.

Miss Ilasz Kazimeira recently visited E&MJ and discussed the present state of European mining. In 1954, she graduated from the University of Cracow, Poland with a degree in mining engineering. She had planned to establish residence in the U.S. and to get a position as mining engineer with an American mining firm.

Kazimeira

Clark

Edward L. Clark has been appointed director of the department of natural resources for the State of Colorado.

Clark has been associated with Four Corners Oil & Minerals Co. since 1955, being responsible for the firm's exploration and development programs. Prior to that time, he was state geologist for the State of Missouri.

William T. Hill, formerly geologist for Putnam Associates, has joined the geological staff of New Jersey Zinc Co.

(Personals continued on p 182)

metal mining modernization

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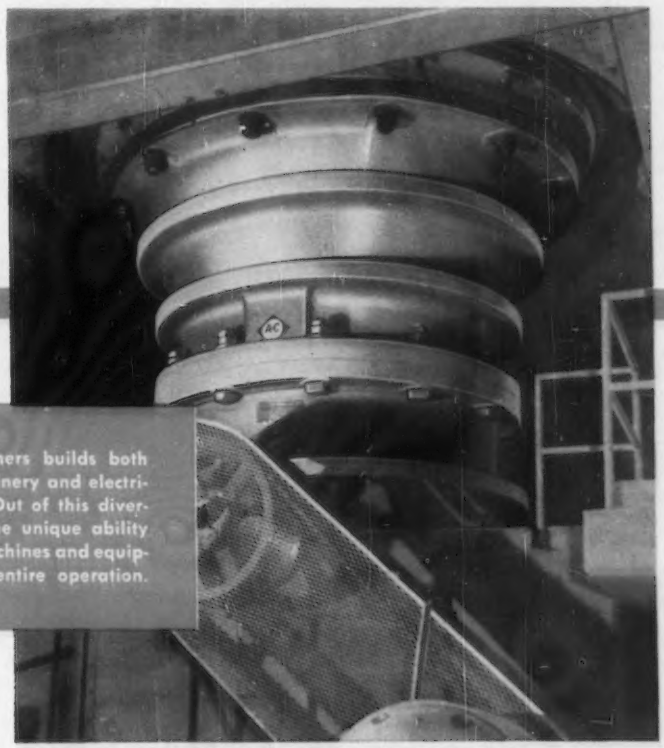

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A CURRENT 50-TPD plant, working on a chrysotile asbestos deposit near Napa, Calif., will be expanded by its new proprietors to 1,000-tpd by late 1960.

Chrysotile Asbestos Plant Will Be Expanded

CALIFORNIA could become the largest producer of asbestos in the U. S. if present expansion plans for a Napa, Calif., mill materialize, according to John H. Lowell, president and director of the Clute Corp., Littleton, Colo.

Lowell announced that the Clute Corp has acquired ownership of Asbestos Bonding Corp., located 16 miles northeast of Napa, and installed its patented negative air separation pilot plant for separation of asbestos fibers. The Colorado air technology company will expand the present 12,000 sq ft facility employing six persons to a 10-unit, 100,000 sq ft mill employing 50-75 people in the next nine or ten months, Lowell said. Work will begin in the near future on the first unit, with a final target date 10 months hence set for completion of the project. New facilities will increase production from less than 100 tpd now to 1,000 tpd when completed.

Possession by Clute of a patented means of separating asbestos fibers from the ore enabled the corporation "to gain full ownership of ABC and energize its plans to build the 1,000-ton mill costing $1-million, and possibly considerably more," Lowell said. During the war there was no means of separating the fibers.

The Napa deposit of Asbestos Bonding Corp. consists of 202 acres of consistent short-fiber chrysotile asbestos. ABC holds a 99-year fee lease on what is the largest known asbestos deposit in the U. S. Its patented mining claims include positive ore reserves established at 1,795,000 tons of short-fiber asbestos, with probable reserves of 5.5-million tons, and possible reserves estimated at 150-million tons. A conservative estimate of the deposit's value would be $80-million, Lowell said. The deposit is an entirely open-pit, volcanic plug operation.

"Location of the Napa deposit is most significant," Lowell stated. "All major asbestos producing mines in North America are located in Eastern Canada. The U.S. has developed the greatest asbestos products industry in the world. Yet we are overwhelmingly dependent on importing 90% to 95% of our raw asbestos from foreign countries.

Lowell said that West Coast manufacturers of asbestos products will realize sizeable savings on short haul freight rates from Napa. He said that asbestos costing $44 per ton in Canada sells here for $80 per ton in carload lots, reflecting freight costs of $36 per ton.

ABC produces 7-R and fine asbestos, for which California provides a big market. The Clute Manufacturing Div. at Rocky Ford, Colo., designed an air separation pilot plant especially for ABC, and the current recovery rate is running at approximately 23% of ore put through, compared to the Canadian average of approximately 10% recovery.

ABC will continue to operate under the direction of its president, Patrick M. Tabor, a vice president and director of the Clute Corp.

Utah Mining's Shaft in Shirley Basin Nears 400

AN ATTEMPT to unlock the uranium riches of the vast Shirley Basin south of Casper is well underway by the Utah Mining Co.

The firm, which has invested $2-million in the mining project, has sunk a 12.5-ft shaft, 330 ft deep into the Wind River shale formation of the basin. The goal is 400-ft and the engineers expected to reach it before Christmas. Mining operations are then expected to begin early in 1960.

"Pound for pound," said an engineer at the plant site, "the Shirley Basin is the second richest uranium province in the U.S. It is exceeded only by Ambrosia Lake in New Mexico."

The rich Gas Hills area, only 80 miles to the west of Casper in Fremont County, may rank higher in total tonnage of ore to be removed in big strip mining operations but Shirley Basin has the richest. Gas Hills ore averages about 0.21%.

Utah Mining began the work of sinking the shaft last June, after the company spent two years drilling test holes and evaluating the ore body which is reported to be 4,000 ft in length and "very rich." At the bottom of the central shaft sunk by Utah Mining, and lined with 12-in. of concrete, two main haulageways will extend easterly and westerly the length of the main ore deposit.

The orebody is described as flat, tubular to lenticular sand beds alternating with shale in the Wind River formation. The formation is Tertiary and well above known oil producing zones. The interbedded sand formations occur like discontinued coal seams. Just how rich the Shirley Basin ore is the engineers won't reveal at this time. They do admit it has to be at least 0.2% uranium in order to justify the costs.

Utah Mining Co. is a wholly-owned subsidiary of Utah Construction and Mining Co. (formerly Utah Construction, one of the nation's big builders). The firm is gambling on big uranium stakes in the future. Although government allocations are limited, the area is so promising that big companies with large capital are reported to be interested in getting a foothold for the future.

At work in the same general area are Tidewater Oil Co. and Kerr McGee Industries who are preparing to develop similar large orebodies. K-Mc plans a big open pit mine, and Tidewater another underground operation. The three firms have received Government allocations for uranium ore, thus insuring a start in the developments of an area which may become one of the biggest sources of atomic power in the future.

The three firms together will mine a volume of ore which the engineers believe will justify the building of a 1,000-ton processing plant within the next two years. That, of course, hinges on the AEC's approval. At present, however, the ore will be trucked to Casper and to processing plants in the Gas Hills, a distance of 150 miles.

The work of setting up the uranium camp and sinking the two-compartment shaft began last June. An average work force of 90 men has been employed in the construction phase. When completed, an operating force of 75 men will work the mine in three shifts around the clock. Trucking will be contracted at $7.50 per ton for hauling the ore the 150 miles to the Gas Hills area processing plants.

One of the problems in sinking the shaft has been lowering the ground water table. Four wells have been drilled around the shaft pumping 2700 gpm. The water runs down a draw near the main buildings and eventually drains into the Little Medicine Bow River. Another well some distance away furnishes drinking water to a trailer camp.

metal mining modernization

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For complete information, see your Allis-Chalmers representative or write for Bulletin 07B8368, Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

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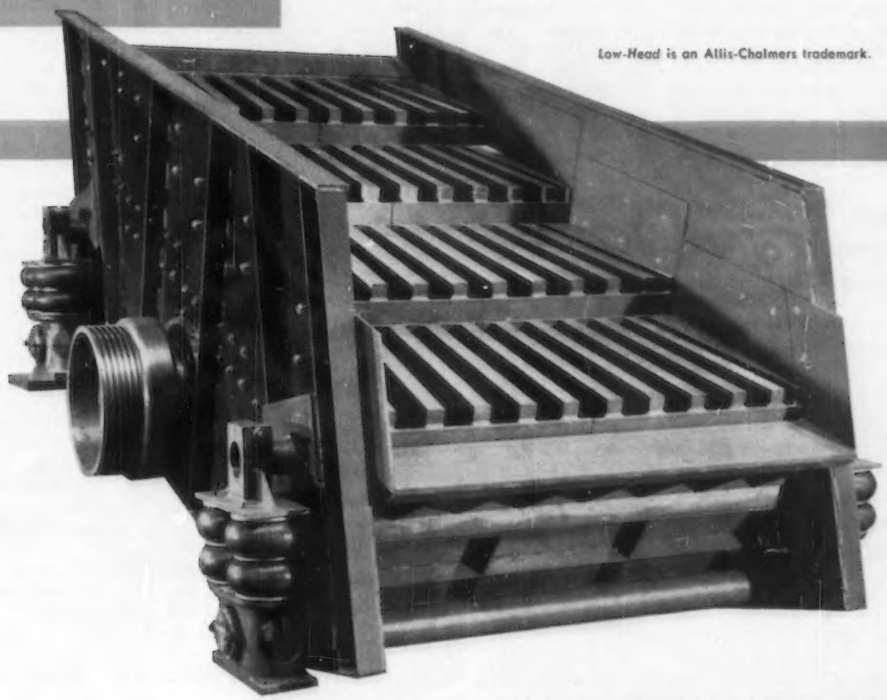

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THIS MONTH IN MINING (*Continued*)

ROBERT BECKER of USBM gives a paper. Chairman Hague is in rear.

J. W. McBEAN of Heath & Sherwood tells of experience with chemical grouting.

Drilling Symposium Features Exploration

THE NINTH annual drilling symposium held October 8-10 at University Park, Pa. by the Pennsylvania State University, Dept. of Mines, the University of Minnesota and the Colorado School of Mines featured papers grouped under four topics:

1. Improved Core Recovery—Papers included summary of diamond bit design, systems of drilling-fluid refrigeration for drilling in frozen ground, drilling and core recovery in unconsolidated materials and chemical grouting with American Cyanamid's AM-9.

2. Statistics and Operations Research —Several papers were given on applications of statistics and operations research to search theory, the optimum prospecting plan and estimation of ore grade.

3. Large Hole Drilling—Topics included deep-hole drilling at Marcona, construction of large-diameter rotary drills and drilling large horizontal holes for utilities on Manhattan Island.

4. New Practices and Updating Old—Papers presented a spectrum of the drilling trade including contract writing, powder metal throwaway inserts for bits, a reassessment of small-diameter drill holes, electromagnetic bore-hole surveying, wireline coring in Northern Rhodesia and summaries of recent experimentation on rotary core drilling on the Mesabi Range.

GE Divulges Catalyst Use in Diamond Making

NOW THAT the General Electric Co. is in volume production of man-made diamonds, the U.S. Government has removed the top secrecy label from any discussion of the process vitals. A recent announcement by GE says that the process requires a catalyst—Cr, Mn, Fe, Co, Ni, Ru, Re, Pd, Os, Ir, Pt or Ta—to convert pure graphite (almost any pure carbon source can be used) to diamond (minus 80 mesh). GE operates the reactors at 2,200 to 4,400°F and from 800,000 to 1,800,000 psi. Without the catalyst, the operating conditions would reach 3-million psi at over 7,000° F.

General Electric's vice president and director of research Dr. Guy Suits says that the reaction time is only a few minutes and that by controlling the temperature, the shape of the diamond can be controlled (depending on its end use in industry). At the low end of the temperature scale, cube shape predominates; mixed cubes and cubo-octa-hedras are produced at the intermediate range, and octahedrons at the upper level.

Color, while of no significance in industrial diamonds, can be controlled with temperature.

Several devices are used to produce the desired operating conditions. One such device—the Belt as it is called—is shown here, which consists of three pieces of Carboloy gasketed with pyrophyllite. The plungers produce the pressure; temperature is produced electrically.

AEC Warns of Stringent Rulings for 1962-1966

URAVAN mineral belt uranium-vanadium producers will have to engage in more selective mining and economical operations in order to participate in the 1962-1966 purchase plans of the Atomic Energy Commission, reports the AEC.

Allan E. Jones, manager of the Grand Junction operations office, said that ores will have to run on average from 0.20% to 0.30% or more U_3O_8 to be acceptable at mills under the price at which AEC will purchase concentrates from those mills.

Producers will be able to ship only economically amenable and metallurgically amenable carnotite type ores to mills which process both uranium and vanadium. The vanadium values will be an important factor in acceptance of ores, as well. Mr. Jones did not detail what the V_2O_5 level probably would have to be.

He told a Uranium Institute of America meeting in Grand Junction in October that AEC would allocate to the small mines on the Colorado Plateau so many pounds of U_3O_8 to be sold during the life of the 1962-1966 purchase period. The allocation would consist of pounds of U_3O_8 in ore. The ore reserve would not be solely determined on basis of what reserve the mines had as of Nov. 1, 1958, because most of the mines under discussion do not have such definable reserves blocked out at present.

Mr. Jones warned that AEC was adhering "very strictly" to the limitations imposed on ore purchasing by Circular Five. In that circular, expiring March 31, 1962, AEC is required to buy only 1,000 tons of uranium-vanadium ores from any one producer in any single year, delivered at Monticello, Utah.

The ore must be amenable, Mr. Jones added. He said that AEC could not force private uranium mills to treat high cost or refractory ores containing carbonaceous material, molybdenum, acid ores, ores running more than 6% in lime, etc. He added that mills which do not recover vanadium could not be asked to process uranium-vanadium ores as the AEC was starting "now" to reject uranium concentrates which run 2% or more V_2O_5.

Net import of his frank discussion: Added penalties and problems for miners of low grade, refractory ores some distance from mills.

Electrolysis Wins Gold From Flotation Tailings

GOLDEN CYCLE CORP. has developed a unique final step that is increasing gold recovery about $6,000 a month at its Carlton mill, Victor, Colo.

metal mining modernization

Savings by the second

Adjusting for wear is a one-man, one-minute operation on Superior crushers

Even on the largest *Superior* crushers, the time it takes to change settings is measured with a stop watch — not a calendar. The secret is *Hydroset* control. Flip a switch, it's that easy. Remarkable *Hydroset* control also facilitates emergency unloading. Remember, only Allis-Chalmers gyratory crushers offer this profit-building speed and convenience.

Bulletin 07B7870 tells the complete *Superior* crusher story. Get a copy from your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

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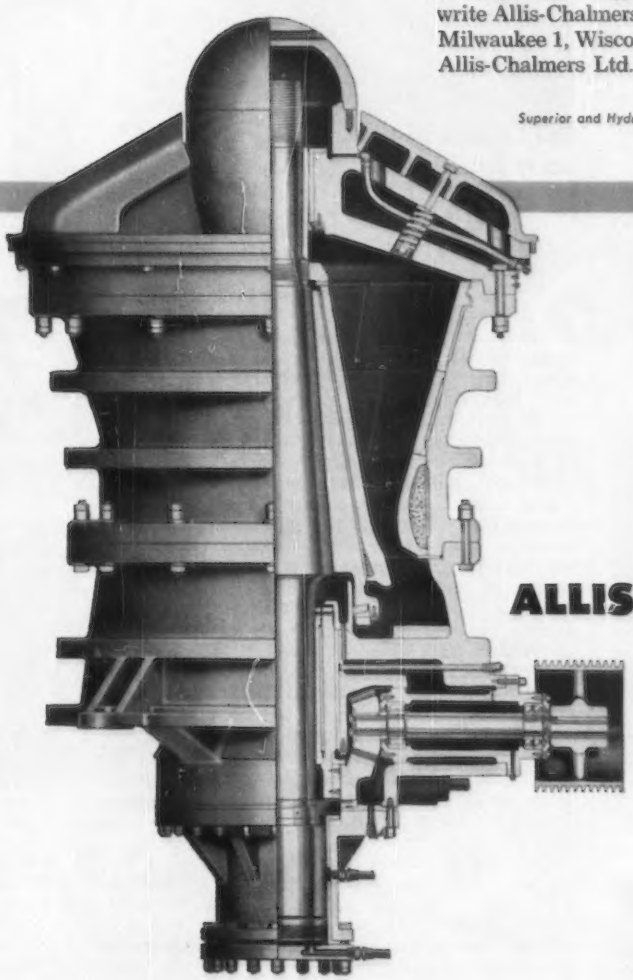

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Electrolytic Au *(Continued)*

The mill, headed by superintendent William C. Klein, uses a low-grade cyanide circuit for treating flotation tailings bearing an average of 5% of the total gold values. Gold remaining in the cyanide pulp from the low-grade tailing circuit is absorbed on activated charcoal, then freed from the charcoal in a hot caustic soda and sodium cyanide solution.

The hot solution is fed to a specially constructed electrolytic cell, designed by Golden Cycle engineers, the gold plated onto stainless steel wool.

GOLD won from the flotation tails plates out on stainless steel wool which forms part of a unique electrolytic cell.

The plated steel wool is removed about twice a month and the gold refined in a regular furnace. This final cyanidation and electrolytic recovery yields approximately $6,000 a month added gold recovery, with very little additional equipment, Klein said.

The electrolytic cell consists of an inner molded rubber basket, perforated over its entire surface to permit passage of the solution. Within this basket is placed a shaft through which solution is fed to the cell. The stainless steel wool is placed around the cell. A layer of stainless steel wire mesh is wrapped around the outside surface of the perforated basket. The shaft acts as one pole of the cell and the stainless mesh as the other, so all recovery takes place within the basket.

The design of the electrolytic cell presented two problems to Golden Cycle's engineers. First, the cell basket and two drums had to resist the heat and deteriorating, corrosive action of the hot caustic solution. Second, they had to be nonconductors in order for electrolytic action to take place and to prevent the gold from plating on the cell walls.

Klein said the natural choice was rubber. In consultation with engineers of Gates Rubber Co., the molded rubber basket and rubber covered drums were designed. The equipment was completed at Gates' plant in Denver, Colo.

IN THE U.S.

ALASKA

Jot Mining Co. of Oklahoma is proceeding with the mining of the Kendrick Bay uranium property on Bokan Mountain, Prince of Wales Island. Ore has been moved to the beach, but no shipments have been made to date.

ARIZONA

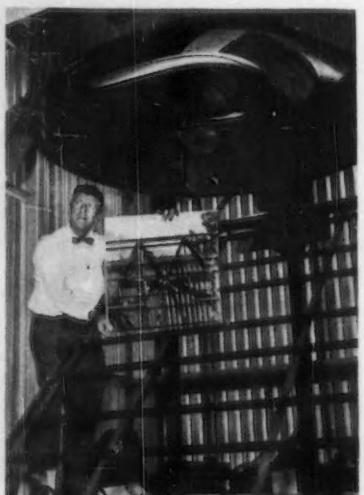
The University of Arizona in Tucson plans to capture free power from the sun to test behavior of metals and new alloys under extreme heat. A solar furnace has been set up on the roof of the college of mines.

By January, metallurgy professor D. J. Murphy hopes to be converting the sun's energy into heat producing temperatures up to 5,000° F. Dr. Murphy will expose specimens of metals and alloys to the heat.

He pointed out that "until recent years steel was an adequate resister to heat. Now with space age research, more durable materials are needed."

Murphy added that the university might make a few alloys of its own for experiments in the solar furnace. The furnace will not be restricted to faculty research. It also will be an important training and research device for graduate students in metallurgy.

Dr. Murphy, who spearheaded design of the furnace, was with the AEC laboratories in Los Alamos, N. M., before joining the Arizona faculty two years ago. A few months later he and several colleagues laid out plans for solar energy equipment.

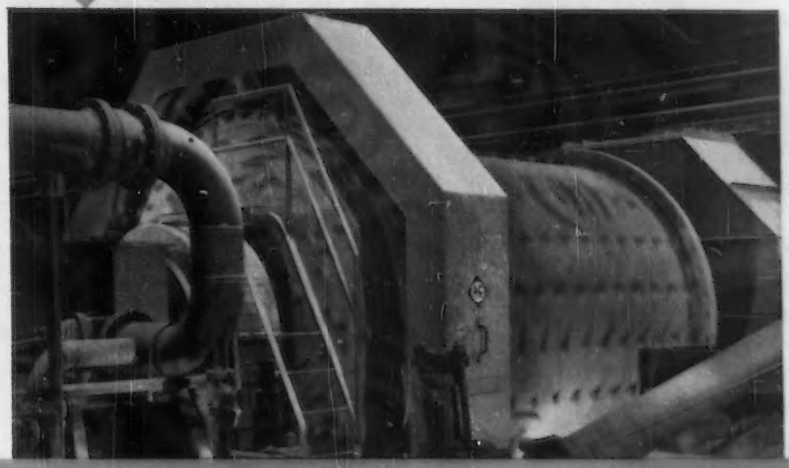


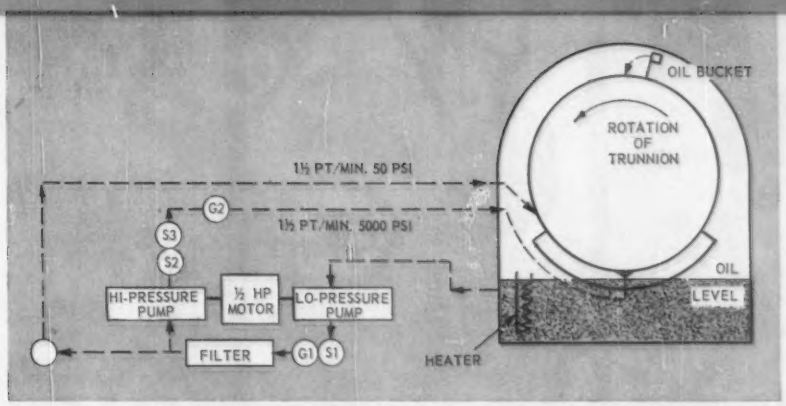
MIRROR PANE for a new metal-testing solar furnace is held by Doctor Murphy.

A surplus army searchlight was acquired to start the assembly stage for the furnace. The frame of the searchlight will support a latticework of 16-mirror panes, each 22 in. square and mounted on aluminum. The mirrors will move

A-C ALLIS-CHALMERS

metal mining modernization





Floating start, ride and stop for big mills

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Volume producers throughout the metallic mining industry are taking advantage of the cost-cutting, space-saving advantages of big grinding mills. When *you* modernize with a bigger mill insist on Allis-Chalmers — the only mill that gives you the positive protection and maintenance economy of *Lubritrol* constant lubrication. These new and bigger mills actually *float on oil.* No bearing-wearing starts. Less wasted horsepower. All functions of the *Lubritrol* system are automatic . . . controlled by foolproof pressure gages and switches.

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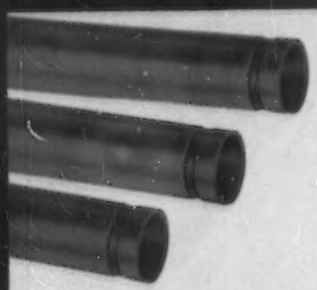

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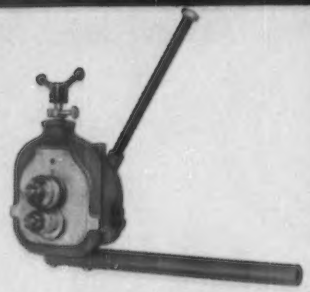

2. VIC-EASY PORTABLE GROOVER rolls grooves into pipe in seconds. Manually or power-operated, this groover removes no metal...retains full wall thickness.

3. VICTAULIC SNAP-JOINT COUPLING assembles and locks by hand—no wrenches or tools required. Other bolted styles of Victaulic Couplings alternately usable.

4. VICTAULIC FULL-FLOW FITTINGS team up with our couplings and lightweight pipe to provide a *complete VIC-EASY system*...cuts costs of installation *and* operation.

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VICTAULIC COMPANY OF AMERICA

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Arizona (*Continued*)

with the search turntable and will be electronically regulated to follow the sun across the sky.

Aimed at the sun, the mirrors will reflect the sun's rays to a smaller set of mirrors housed 25 ft away inside the furnace shelter. The second mirrors will bounce the sunlight upward a few feet against a highly-polished concave metal surface 5 ft in dia which serves as the reflector for the surplus searchlight.

On another bounce downward, the sunlight will be focused into a shaft of heat on a quarter-inch point. It's that focal point that ultimately will strike the specimens of metal hanging 2 ft below the top of the searchlight reflector. An arrangement of the university furnace will allow observers to watch reactions of the metal specimens which will be enclosed in a glass vacuum globe.

Shutters that resemble a large venetian blind will regulate the flow of sunlight from the first set of mirrors into the furnace shelter. About $10,000 has been invested in the equipment. Operational cost will be extremely low, giving the furnace an important economical advantage over expensive heating methods, such as electrical arcs. Dr. Murphy added that "solar heat is clean heat, too. We won't have to worry about impurities in the atmosphere while we're doing our research."

CALIFORNIA

Four companies are presently drilling test bores in Death Valley. The president of one of the companies reported that "promising" deposits have been found at the southern end of Death Valley National Monument. However, Howard I. Young, president of American Zinc, Lead & Smelting Co., St. Louis, added "It may take as long as six months before we know whether the lode is rich enough to be worth mining." Companies known to be taking part in the venture are the American Zinc Sales Co., a subsidiary of American Zinc, Lead & Smelting Co., Midwest Oil Co., Denver, Peerless Gas & Oil Co., Denver, and South African Consolidated Gold Co., London.

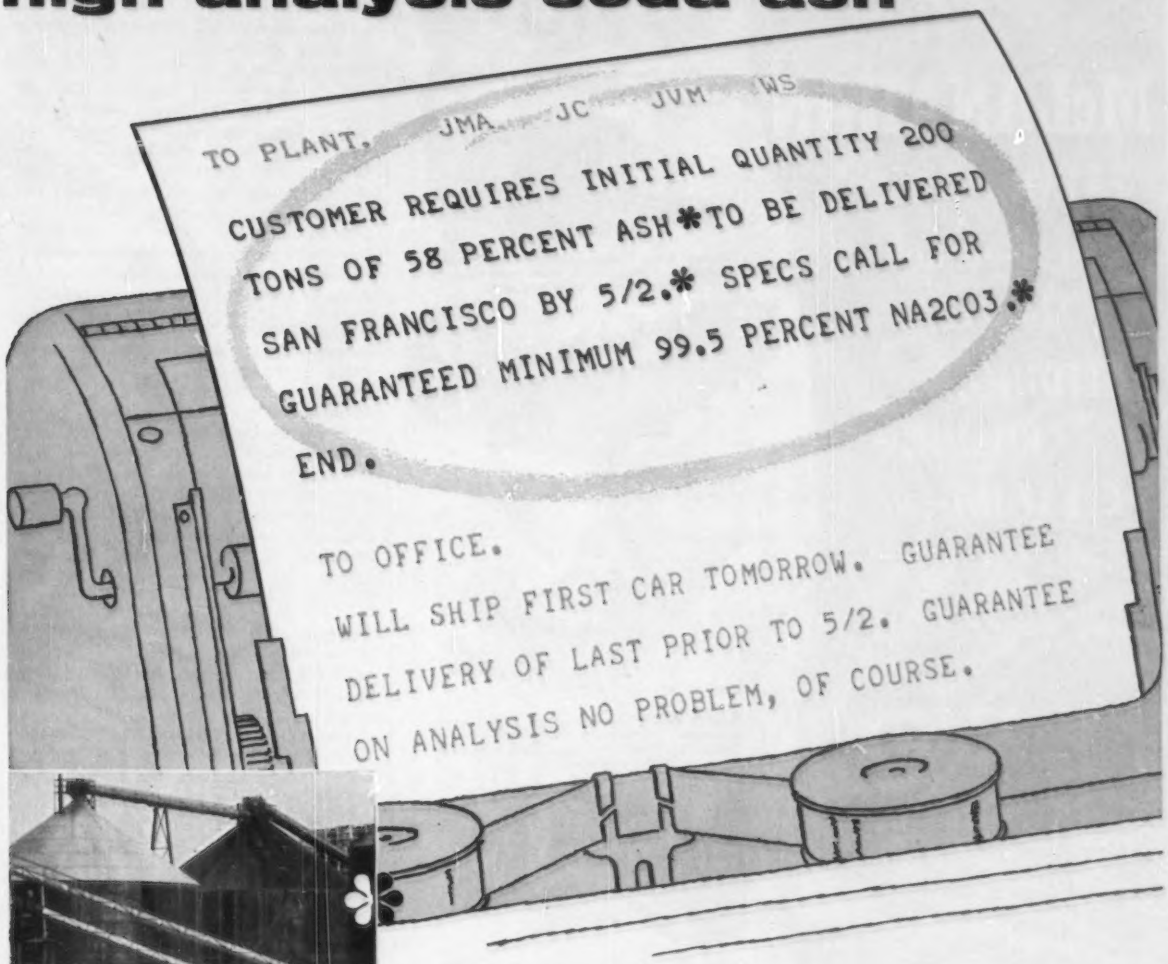
Calaveras Cement Co., a division of the Flintkote Co., will build a $14-million cement plant at Redding, with construction to begin "as soon as possible, as a completion date is desired by March, 1961," according to William Wallace Mein, Jr., president of Calaveras.

COLORADO

Mineral Concentrates and Chemical Co. announced it is beginning the nation's first commercial production of beryllium oxide from domestic ores at new plants in Loveland and Berthoud, Colo.

R. S. Myre, general manager, said the firm has perfected a chemical extraction process to produce beryllium oxide from beryl ore mined in Park County, Wyo.

West End "fills the order" for high analysis soda ash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Storage for 25,000 tons of industrial chemicals

Immediate shipment in leased hopper cars

Constant control for uniformly high quality

Meeting service requirements to the letter and producing superior soda ash of consistently accurate particle size and chemical analysis are the essentials to which the West End organization is uniquely geared. A system of rapid communications linking our sales office in Oakland with our production, technical and shipping departments at the desert plant site permits each department head to have a complete understanding of the customer's individual requirements and to make firm commitments or provide the desired information promptly.

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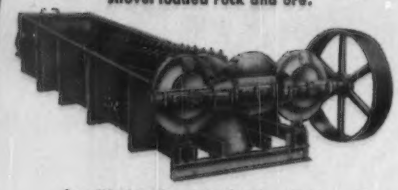
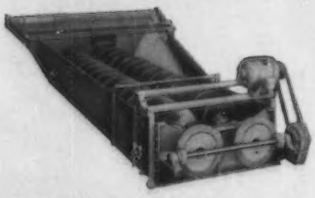
A pioneer in the development of many types of processing equipment, McLanahan has served domestic and foreign pits, mines and quarries for more than a century. Shown are a few illustrations of McLanahan equipment for crushing, washing, sizing and conveying all types of ore, rock, coal and other materials. Technical details and price information will be sent upon request.

All Steel Rockmaster Single Roll Crusher for primary or secondary work on shovel loaded rock and ore.

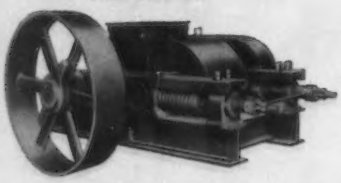
Heavy Duty Reciprocating Plate Feeder. Handles any materials from sand sizes to shovel loaded rock and ore.



Log Washer for removing tough clay and soft rock from various materials.



Double Screw Washer (with gear cover removed), for dewatering, classifying and removing waste from sand, limestone and other materials.



Heavy Duty Fabricated Steel Double Roll Crusher for secondary reduction of rock and ore.

Double duty combination Scrubber and Sizing Screen for large and small capacities.

Paddle Mill Scrubbers of various capacities for cleaning large size feed.

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Colorado (*Continued*)

(E&MJ, October, p. 130). Production from the Boomer mine in Park County has been sold in the past to the U.S. for stockpiling.

Myre said a high temperature furnace designed by Pacific Foundry Co. has been installed at the Loveland plant. He said it has produced beryllium oxide assaying 99.99% pure. He further said Brush Beryllium Co. of Cleveland and Beryllium Co. of Reading, Pa., have been processing beryllium imported from Africa, South America and India. The two eastern firms, Myre reported, can process only high grade beryllium ore, but the Mineral Concentrates plants can handle the low grade ore which predominates in the U.S.

Rico Argentine Mining Co. made less money while operating lead-zinc properties at Rico, Colo. in last fiscal period, than it did in a previous year of mining shut down.

A key to the situation was operating levels at the firm's pyrite-sulphuric acid production unit. But Sherman B. Hinckley, president and general manager at Salt Lake City, said Rico had a net operating income before depreciation and depletion of $199,824. That compares with net on a like basis of $355,693 for fiscal 1957-1958.

There are two potentially big operations in the Idaho Springs area and another mine has been making a sustained production of high grade ore for several months.

The Big Five operation has leased the Silver Spruce mill at the east end of Idaho Springs and has put the first trial run of ore through it from the raise they have been driving in the Big Five tunnel. The raise was made about a mile and a half in from the portal of the tunnel so laterals could be run to the Lake and Belman vein systems to get above old workings of the veins from tunnel laterals driven from the Big Five tunnel level years ago.

Bruce Anderson of Denver and Richard L. Peterson of Douglas, Wyo., are presently driving a drift to intersect the Cashier vein on Teller Mountain in Summit County.

It is expected that something over 500 ft of drift will be required to intersect the vein in an area of the old workings. Nearly 100 ft of drift has already been completed. The Cashier property produced high grade silver-lead ore in the early days but has not been mined since the turn of the century. Ore taken out during its operation averaged about 200 oz silver and a high percentage of lead.

Globe Hill Mining Co. says its uranium program at the Phonolite Mountain mine near Cripple Creek as been progressing right along. They have done surface stripping and have turned up a new orebody. They have been delayed considerably—much longer than expected—in getting final certification from AEC. Everything now seems to be in order and they hope to be able to ship regularly from the property. The project is a joint venture with Trans-Mountain Ura-

(*Continued*)

nium Co. Globe Hill still has the Beryllium property in South Park, Colo., and the Elk Park uranium property (18 claims) near Silverton.

Nat and Muriel Gould have announced the leasing of their Elisha uranium claims on upper Cochetopa Creek, but for the extraction of mercury. Lessees of the eight claims for the next three years are Leslie Dunlap and Roy Busby, both of Denver. The claims had previously been optioned by the Goulds to Thornburg Brothers for uranium development, but the option was given up.

The new gallows frame at the Ajax mine at Cripple Creek, a heavy steel structure, was moved from the Pikeview mine north of Colorado Springs by Vetter and Sons. It is 20 ft higher than the old one. An 84-in. sheave wheel tops the structure

Henry Nelson, county commissioner, told AMC members of shipments that are being made to New Jersey from a big deposit of iron ore on the Clear Creek County-Park County line. The iron has been found desirable as a paint pigment and it could develop into a big operation.

W. H. Pattison, the State Land Board's mineral director, has disclosed that the agency has issued placer gold leases on almost 5,000 acres of school land north of Craig in Moffatt County. Pattison said it's the first extensive activity in placer gold leases by the board "in 30 to 40 years." All leases straddle Fortification and Four Mile creeks between Craig and the Wyoming line.

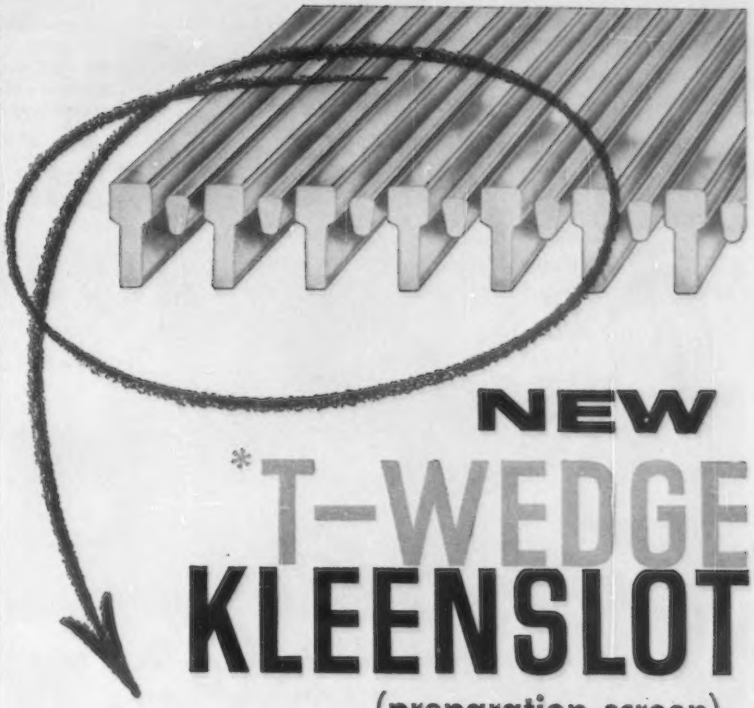
Pattison agreed interest in gold mining apparently was spurred by Joseph Stephan, Craig mining engineer. He claims to have perfected a new machine for separating very fine gold particles from sand and gravel beds.

Russell Wood, head of Shenandoah Ltd., has announced at Silverton, the construction of a new sampling plant at the Shenandoah mill. The first work on the new plant is now under way and should be ready for use in the spring.

The new sampler, estimated construction cost between $60,000 and $75,000, will be designed to receive ores from the Sunnyside, the Shenandoah and custom ore. It will have a capacity of 100 tph and be equipped with automatic sample-cutters. The primary jaw-type crusher will be 24x36 and will handle up to 22-in. rock. The secondary will be a 4-ft. standard cone-type. First samples will be cut at 3 to 4 in. The plant should be ready for operation June 1. An entirely new building will house the plant and will be of steel construction 91x36 ft.

IDAHO

The Department of the Interior announced that in October the Office of Minerals Exploration executed a contract with the Golden Copper Queen Mining Corp. of Pocatello for financial



NEW

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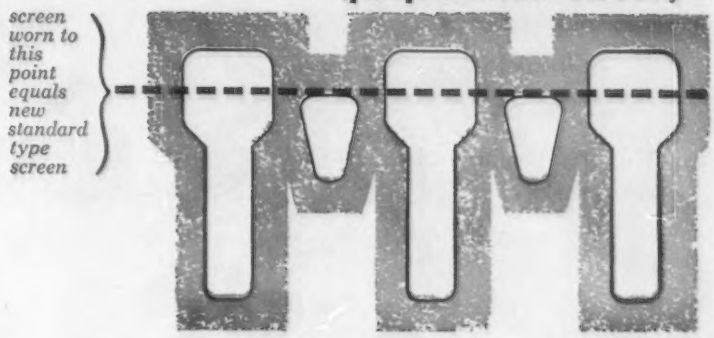
KLEENSLOT

(preparation screen)



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with *I. F. A. *independent flexing action for non-blinding, non-clogging performance*

new T-WEDGE screen is especially adaptable for flumes or vibrator applications—can be easily interchanged with other types of Kleenslot screens without mechanical changes—abrasion resistant stainless steel

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Make sure of good threads every time. Order RIDGID Thread Cutting Oil from your Supply House today. Tops for *all* metal cutting . . . you'll want an extra supply for your lathe, drill press and other metal cutting equipment.

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Idaho (*Continued*)

assistance to explore for copper in Lemhi County. Estimated cost of the work is $40,270, and maximum Government participation is 50%, or $20,135.

Preliminary plans for the new half million dollar school of mines building at the University of Idaho have been approved by the board of regents and the call for construction bids has been set for Feb. 1. Work on the building, half of the cost of which is being borne by mine companies and mining men of the West and the other half through an Idaho legislative appropriation, is scheduled to start in the early spring.

First use of steel shaft sets in the Coeur d' Alene district is reported by J. C. Kieffer, manager of the northwestern mining department of American Smelting & Refining Co., who said the steel sets are being installed in the new No. 3 ventilation shaft at the company's Galena mine west of Wallace. The mine's silver vein has been opened along its full length on the 4,000 level and a station is being cut for operations on the 3700 level, Kieffer said.

Samson Oil & Mineral Co. of Fort Worth, Texas, has acquired control of the Silver Star-Queens Mines, Inc., at Hailey. Joe A. Foster of Fort Worth, president of Samson is the new president of Silver Star-Queens. Also on the board are two other officials of Samson. Samson Oil & Mineral acquired control of the company at its recent meeting in Portland when an offer to buy the treasury stock at 1c per share and to pay at least two assessments on the stock was accepted. Foster said Samson would proceed with the present Silver Star-Queens work program, which includes extensive exploration of the Minnie Moore mine in the Hailey section of Idaho.

Iron ore stockpile, equipment and mining property of the Shasta Mining Co. near Weiser have been taken over by Glen Clark of Weiser from the Shasta Coal Corp. and he will proceed with mining and comply with milling orders held by Shasta. Expanded operations are scheduled in the spring.

R. H. Bailey, president of the Midvale Mining Co. has entered into an agreement with W. J. Logus, president of the Vindicator Silver-Lead Mining Co. of Idaho, for an extensive diamond-drilling program on Midvale's claims in the Mullan-Purke section of Idaho. Logus was added to Midvale's board.

Dean Koethke, Kellogg, has entered into an option agreement with the Big Iron Mining Co. of Colville, Wash., to carry on extensive work at the company's claims in the Colville area. He plans to start work in early spring.

A $2-million clay and silica plant under construction at Bovill, by J. R. Simplot Co. will go into production about Jan. 1, 1960, officials of the company said. P. T. Peterson, resident manager for the firm, said that the plant is expected to handle about 500 tpd raw feed.

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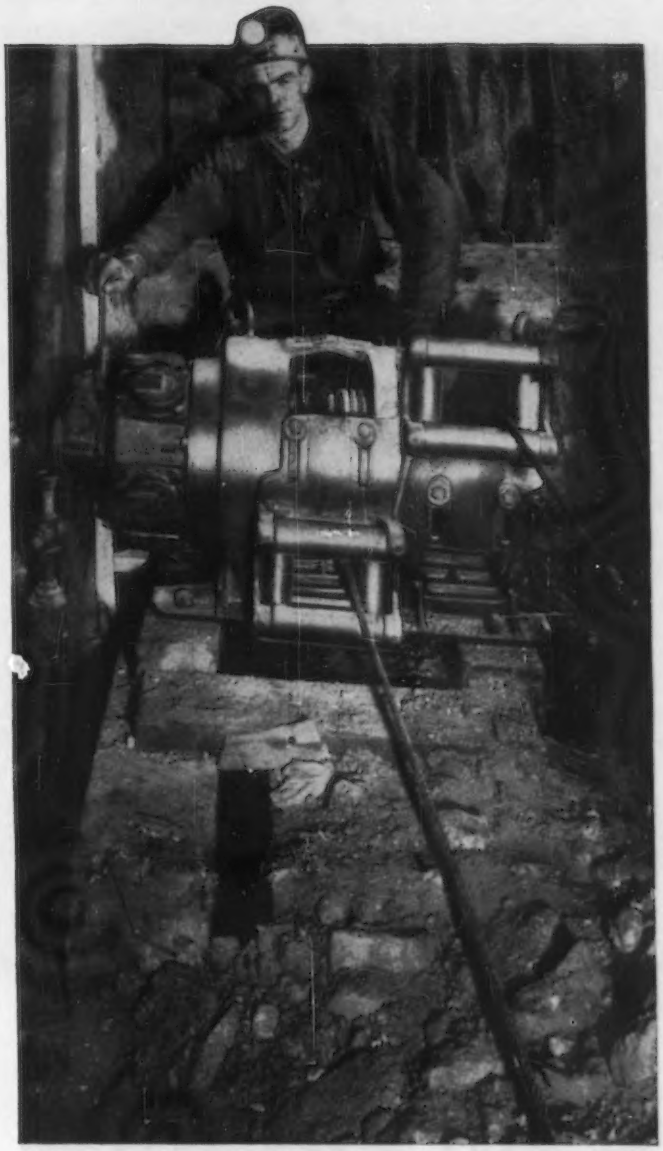
. . . power for a full scraper every trip

. . . speed for faster round trips

Plenty of slushing power—high-torque, 5-cylinder radial air motor provides digging and tugging power to fill scraper on every pass.
Easy to operate—single lever controls power in either direction. When lever is released, air motor stops—does not waste air idling.
Stays underground—air motor and drive are completely enclosed to keep water and dirt out . . . oil in. Parts are designed to deliver maximum service with little maintenance.
No clutch facings to wear—simple roller clutch automatically and instantaneously engages one drum and releases the other as throttle is reversed.
Only three points to oil—air motor, gear train and throttle valve.

Move more muck with the finest of slusher hoists—Gardner-Denver "Airslushers." Write for details.



CALL THE GARDNER-DENVER MAN

Your Gardner-Denver mining equipment specialist is trained to assist in drilling and mucking problems . . . to help keep your Gardner-Denver equipment in tiptop shape. At Gardner-Denver *there's no substitute for men*—our 100-year philosophy of growth.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

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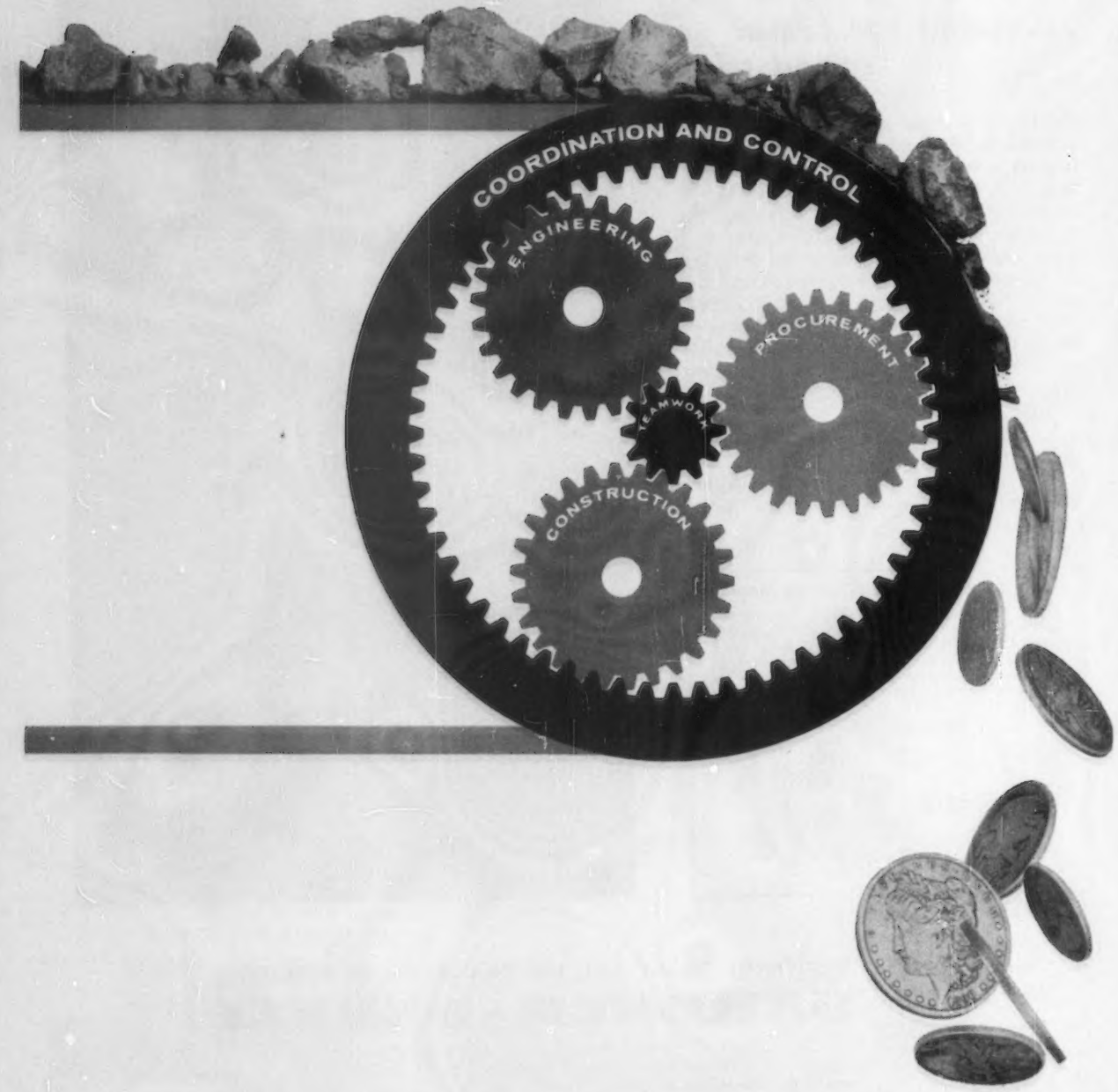
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ENGINEERING
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GEARED TO DELIVER ORE DRESSING PLANTS AT GUARANTEED COST

THE M. W. KELLOGG COMPANY provides engineering, procurement, and construction services *in depth* . . . and *under one central management*. This unique concept achieves a degree of coordination and control that enables Kellogg to guarantee, in advance, what your major facility will cost.

In engineering, Kellogg excels in design and in layout and materials flow. Special groups of long experience handle mechanical equipment, structural engineering, foundations, electric power, furnaces and heat exchangers, instrumentation, and process engineering where needed. Mastery of modern materials handling methods brings new economies in capital expenditures and new savings in operating costs to clients.

In procurement, Kellogg criteria extend far beyond buying at the best price. To provide greater value in plant, to advance the day production can begin, every procurement activity is coordinated with engineering and construction needs. Encompassing purchasing, inspection, expediting, and traffic, Kellogg procurement is geared to the top management goals of providing the most plant per dollar.

In construction, Kellogg stands unsurpassed in achieving top labor productivity, in devising economical solutions to tough erection or installation problems, and in keeping on schedule. Kellogg's construction department is organized to concentrate attention on these major areas: labor productivity, construction methods, construction planning, standards, engineering and inspection, tools and equipment, scheduling, administration, safety, and labor relations. A day-by-day check on progress *cost* is standard on Kellogg construction jobs.

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WIDE EXPERIENCE IN HEAVY CONSTRUCTION. The M. W. Kellogg Company is a world-wide contracting organization serving clients on all continents—Africa, Asia, Australia, Europe, North America and South America. For the world's industries, Kellogg provides integrated engineering-procurement-construction services and specialized facilities to build the most complex plants.

Founded in 1901, Kellogg has operated throughout the world since World War I. Since 1945, Kellogg has constructed more than 350 industrial plants—often handling 50 major projects concurrently. Some have been unique, high-capacity units embodying new process concepts. Many have been huge industrial developments basic to their national economies.

The revolutionary Kellogg way of doing business, well-established in other industries, is bound to have a profound effect on big mining projects. Why not let Kellogg engineers explore with you the ways in which they could best serve *your* interests? As a preliminary step, send for brochure—"Planning the New Plant for Profits".

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Firestone *Giant Tire Service* keeps equipment working around the clock

Firestone's *Giant Tire Service* puts a Firestone off-the-highway Tire Expert on your job *whenever* you need him. With his completely equipped service truck, he'll handle all your tires from the biggest to the smallest. He'll check your tires regularly for proper inflation and spot potential trouble areas before they develop. Combine Firestone's Giant Tire Service with Firestone off-the-highway tires to bring down tire costs. There's a tubeless or tubed tire built with Firestone Rubber-X, the longest-wearing rubber ever used in Firestone tires, for every construction job. Call your Firestone Dealer or Store about Firestone's Giant Tire Service today.

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When ordering new equipment always specify Firestone tires.

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Sacramento	GI 2-0445
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Florida, Jacksonville	EL 4-1414
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Firestone

BETTER RUBBER FROM START TO FINISH

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Idaho (*Continued*)

Mining operators of the Coeur d' Alenes have spent almost $2-million on a dredging project to prevent contamination of Lake Coeur d'Alene by lead from mill tailings that are dumped into the Coeur d'Alene river. The sum was reported by officials of the dredge fund group of mining firms which have financed the dredging project since it was started in 1934.

The dredging is done in the Mission Flats area between Kellogg and Coeur d'Alene and near Cataldo. More than 23 companies have contributed to the fund over the years. Material pumped by the dredging operation for the past two years is being used to form a dike that will become the roadbed for a relocated section of U.S. Highway 10, part of the interstate highway system in northern Idaho.

Bunker Hill Co. has contributed about one third of the total cost of the project, despite the fact that the firm impounds its own mill tailings at Kellogg.

INDIANA

Aluminum Company of America is resuming limited construction of its $80-million aluminum smelter at Warrick, Ind. Planned smelting capacity—150,000 tpy. Construction was halted last year because of the recession.

IOWA

The first gypsum was removed last month from the U.S. Gypsum Co. new mine at Sperry, Iowa. It is one of the deepest gypsum mines in the country, second only to the 775 ft deep USG mine at Plasterco, Va.

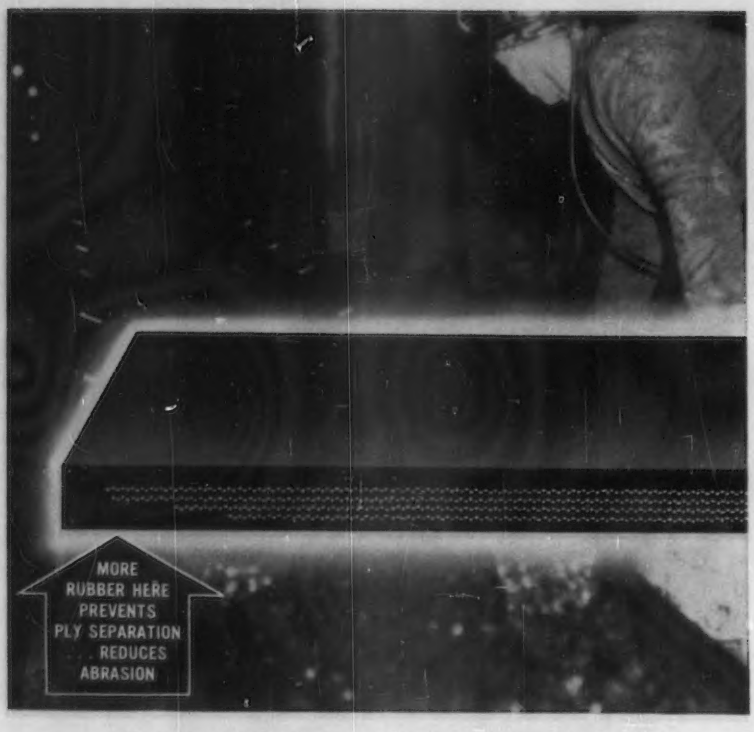
The two 600 ft vertical mine shafts were sunk by the Western-Knapp Engineering Co. WKE is also doing the initial mine development work as well as the engineering and construction of surface facilities at the mine.

Although regular mining operations are not scheduled to begin until early spring 1960, approximately 15,000 tons of gypsum will be removed through the ventilating shaft as miners develop the drifts connecting with the main shaft 300 ft to the north. The rock will be stockpiled to provide an initial supply of gypsum for the plant when it opens early next year.

MICHIGAN

A contract for fabrication of 35 conveyor units for the new Humboldt Mining Co. iron ore pelletizing plant at Humboldt, has been awarded to Lake Shore, Inc., according to B. W. Reeve, Lake Shore president.

The heavy-duty conveyor systems will be 850 ft long, and will use 1,852 ft of belting. The contract also includes all necessary conveyor pulley, coupling and



EXCLUSIVE "COLEDGE"* CONSTRUCTION

gives Quaker Thermoid Conveyor Belting extra life where it counts

Unique "Coledge" construction puts more rubber *at the edges* where it's needed, prevents ply separation, makes a more flexible and wear resistant edge where abrasion is greatest. Punishment at the edges—especially the tough use dealt out in mining—can kill most conveyor belting in a fraction of the lifetime of Thermoid-Quaker belting.

Tests show Thermoid-Quaker "Coledge" construction lasts and lasts on the same jobs where other belting fails. "Coledge" construction is available on all grades of Thermoid-Quaker belting.

What's more, all Thermoid-Quaker conveyor belting is prestressed in manufacture, so that the belt is actually in compression when you get it—ready for the heaviest load without strain.

Examine Thermoid-Quaker Belting with the exclusive "Coledge" construction at your Thermoid distributor's, or write for further information to Thermoid Division, H. K. Porter Company, Inc., Tacony & Comly Streets, Philadelphia 24, Pa.

*Patent Applied For

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Michigan *(Continued)*

control equipment for the 2,000-tpd plant being built by Arthur G. McKee & Co., Cleveland, Ohio.

It is the first low grade iron ore pelletizing plant to be constructed on the Michigan iron range. The Humboldt firm is jointly owned by Ford Motor Co. and Cleveland Cliffs Iron Co.

The new pelletizing plant is scheduled to begin operations in mid-1960, and will produce pellets from iron ore concentrates.

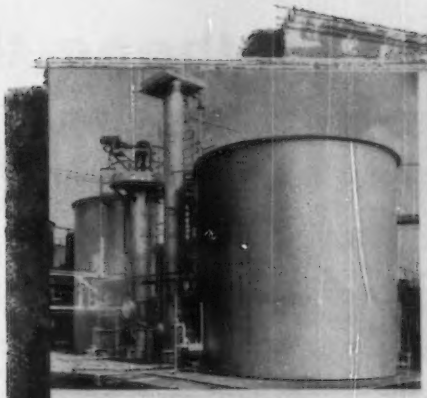
The report of Iron County mine inspector, Reino Anderson, for the year ended Aug. 31, 1959, showed 34 accidents in Iron County mines, during the year, the lowest since 1940 with 31 accidents. Fatalities, at seven, were the highest since 1952 when there were eight. The June 1 disaster at the Sherwood mine (E&MJ, Aug., p 127) accounted for six of the seven. Tons of ore produced per fatality was 418,896; while in the preceeding year that figure was 2,206,707 tons. The last year with no fatalities was 1945. The county's ore production for the year was 2,932,272 tons from seven producing mines. The year before it was 4,413,414 tons from ten mines. As of August 31, 1959, a total of 1451 men were employed at the mines. The year's low production was due to the strike which began on July 14 and to a shut-down of the Buck mine from July 1958, to April 1959. M. A. Hanna Co.'s Cannon mine was the couunty's largest producer, 608,263 tons, and that company's Wauseca mine was second with 523,227 tons. The Cannon had the largest number of employees, 279; the Hiawatha, 274; the Homer, 234 and the Wauseca, 197.

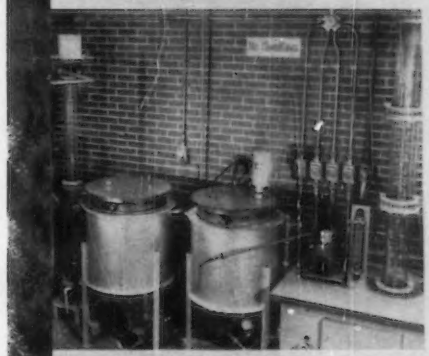
MINNESOTA

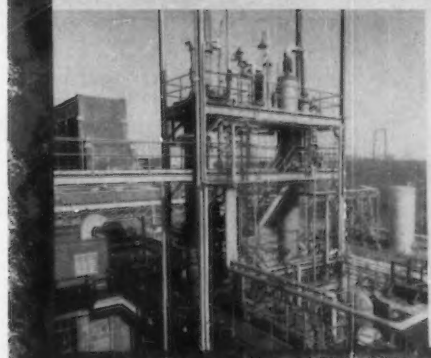
The first cargo of iron ore shipped in almost two months left Duluth-Superior harbor Oct. 27. The load of about 1,000 tons was taken on by the *SS La Salle* of the Cleveland-Cliffs Iron Co. at the Great Northern docks. It will be unloaded in Buffalo. E. F. Oviatt, dock superintendent, said some of the ore was on hand when the steel strike began, some was shipped in from Montana, and some was brought in from non-union mines on the Mesabi Range.

Total iron ore shipments from the Mesabi Range for 1958 show the highest natural iron (53.78%) and the lowest moisture (8.49%) for at least six years. That probably reflects the effect of the increasing tonnages of taconite pellets with their high natural iron and negligible moisture.

Oliver Iron Mining Div. made a bid on Oct. 23 to buy, from the state, 2,590 acres of tax forfeited lands near Mt. Iron for a possible taconite plant. The company makes no commitment as to building a plant, now or in the future. It states only that, if it should decide to build a plant, it wanted title to the necessary acreage. The land and timber on it have been appraised at a total value of $60,089. Tax forfeited lands were of-







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Furfural—lube oil extractions.

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Above you see RDC columns in successful operation for manufacturers of chemicals, petro-chemicals, petroleum and foods. Production size or pilot plant models available. Write or phone General American for Bulletin #T-1159. If you wish, our engineers will be glad to discuss your requirements and recommend the equipment that will do your work most efficiently.

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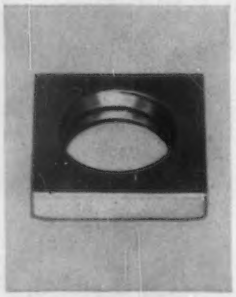
Have you checked these three
REPUBLIC MINE ROOF

✔ PRECISION-TAPERED PLUG

Engineered for proper shell expansion. Note angle of taper in illustration—the precise degree required for strength, dependability, and quick efficient tightening. This improved Republic plug is versatile and adaptable, and is particularly effective in relatively soft formations.

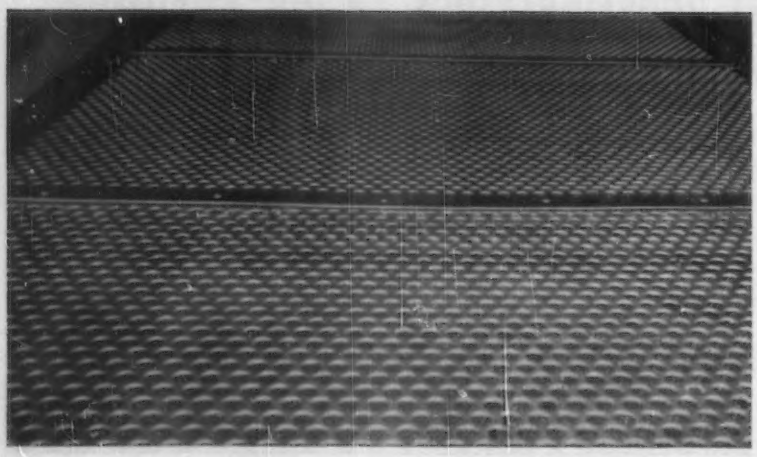
✔ HEAVY-DUTY SUPPORT NUT



Square nut provides over 40% better support than even the best previous method, yet maintains proper bolt tension by stripping at approximately 50 pounds torque with no damage to bolt threads. Here's another point: nut can be applied either side up to expedite assembly.

REPUBLIC ELECTRUNITE GROOVED-END TUBING offers cost-saving, time-saving advantages in many mining applications. It is quickly and easily joined with Victaulic Couplings. Portable field grooving equipment is available, too. Grooved-End Tubing is ideal for air, water, drainage lines, tunneling, and other heavy duty operations. As work moves ahead, lines can be taken up and relaid to conform with changing needs. Strong, rugged; engineered and produced to meet severe laying conditions. Send coupon.

SUPERIOR STRENGTH PLUS CORROSION-RESISTANCE are two of the many features of Republic High Strength Steel which make it ideal for a wide variety of mine industry applications. In mine car and hopper car use, for example, these factors contribute to greatly reduced maintenance. Republic High Strength Steel also provides good impact and abrasion-resistance. It will pay you to evaluate all of these advantages in terms of your equipment performance specifications. For more information, mail coupon.



SUPERIOR PERFORMANCE OF REPUBLIC ENDURO® STAINLESS STEEL used for this cleaning plant shaker screen has drastically reduced replacement expense. Reason is the excellent resistance of Republic Stainless to abrasion and corrosion. Other characteristics which pay service dividends in mine equipment applications include its good strength-to-weight ratio, easy cleanability, and high impact strength. In addition, Republic Stainless Steel is readily formed and welded, simplifying both manufacturing and maintenance operations. Mail coupon.

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✓ IMPROVED SELF-CENTERING HEAD

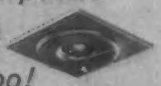
Compact, one-piece head eliminates need for second washer. Heavy flange, and thick, reinforced washer are guided cleanly and firmly into position in bolt plate. Entire unit forged, for ruggedness and strength. Standard 1⅛" head available with ¾" and ⅞" bolt sizes.

✓ CHECK THE COMPLETE UNIT

Can be shipped fully assembled as shown here

. . . to prevent loss of parts, prevent damage to bolt threads, save you assembly costs. Improved Republic RS-1 Expansion Shell, shown, provides extra strength, easy installation, in strata of any type.

Specify Republic Roof Bolt Plates, Too!



MINE ROOF BOLT MATERIAL CONTROL CERTIFICATE
Republic Steel Corporation hereby certifies that the mine roof bolts included in mill order number _____ were made from the following steel:
The above figures are record as contained in the official records of the Corporation.
REPUBLIC STEEL CORPORATION
General Offices • Cleveland 1, Ohio

MATERIAL CONTROL CERTIFICATE with every Republic Roof Bolt shipment gives specific physical properties of steel used. Data includes yield point in pounds per square inch, yield and break point in pounds, and steel heat number. Guesswork about performance is eliminated!

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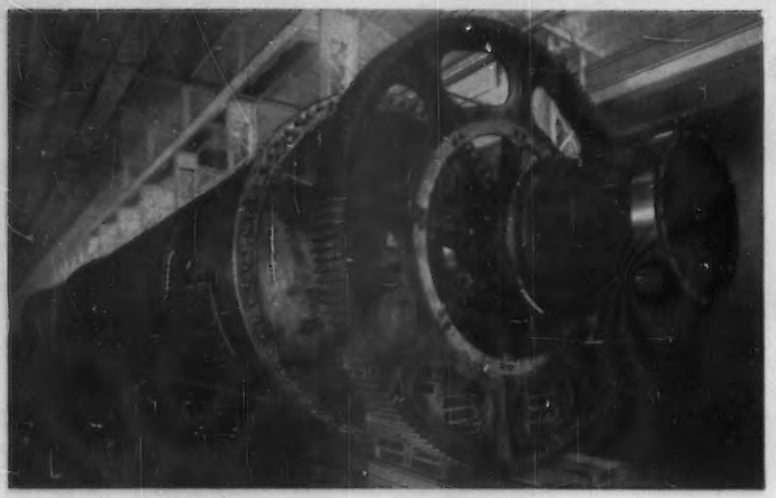


Ruggles-Coles

ROTARY COOLERS IN FOUR TYPES

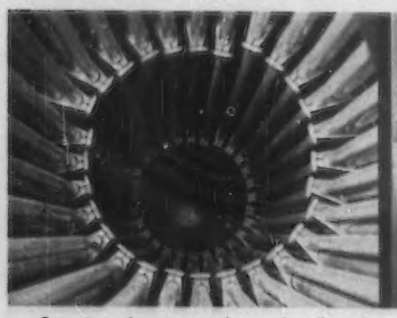
GAS-COOLED TYPE—Solids are cooled by direct contact with cooling air (atmospheric, or dried and refrigerated). Inert gases may be used in a closed system.

WATER-COOLED SHELL—Water is externally applied to the shell, either by sprays or by partially submerging the shell.

TUBULAR TYPE—Internal water-cooling tubes are assembled with the rotating shell, or installed as a stationary bank of tubes concentric with the shell. Alternately, the water leaving either of these tube sections may be used for supplemental spray cooling on the shell exterior.

DIRECT-CONTACT WATER—For rapid cooling from very high temperatures, water is sprayed directly on the hot material to utilize the latent heat of vaporization. Usually supplemented by secondary air cooling.

Each of these types has a particular area in which it is most economically applied. Write for further information.



Interior of a water-tube cooler. Longitudinal banks of tubes provide maximum cooling surface for minimum floor space.

Interior of partially-submerged cooler with gravity-controlled scrapers maintaining clean shell surface for high-rate heat transfer.

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Minnesota (*Continued*)

fered for sale in Duluth Dec. 7. The Oliver is expected to be the only bidder on this particular land as no mineral rights are involved. It is near the location of Oliver's Pilotac plant which has been in operation since 1953 and has shipped a total of 3,170,938 tons. Its largest shipment was in 1958 with 732,938 tons.

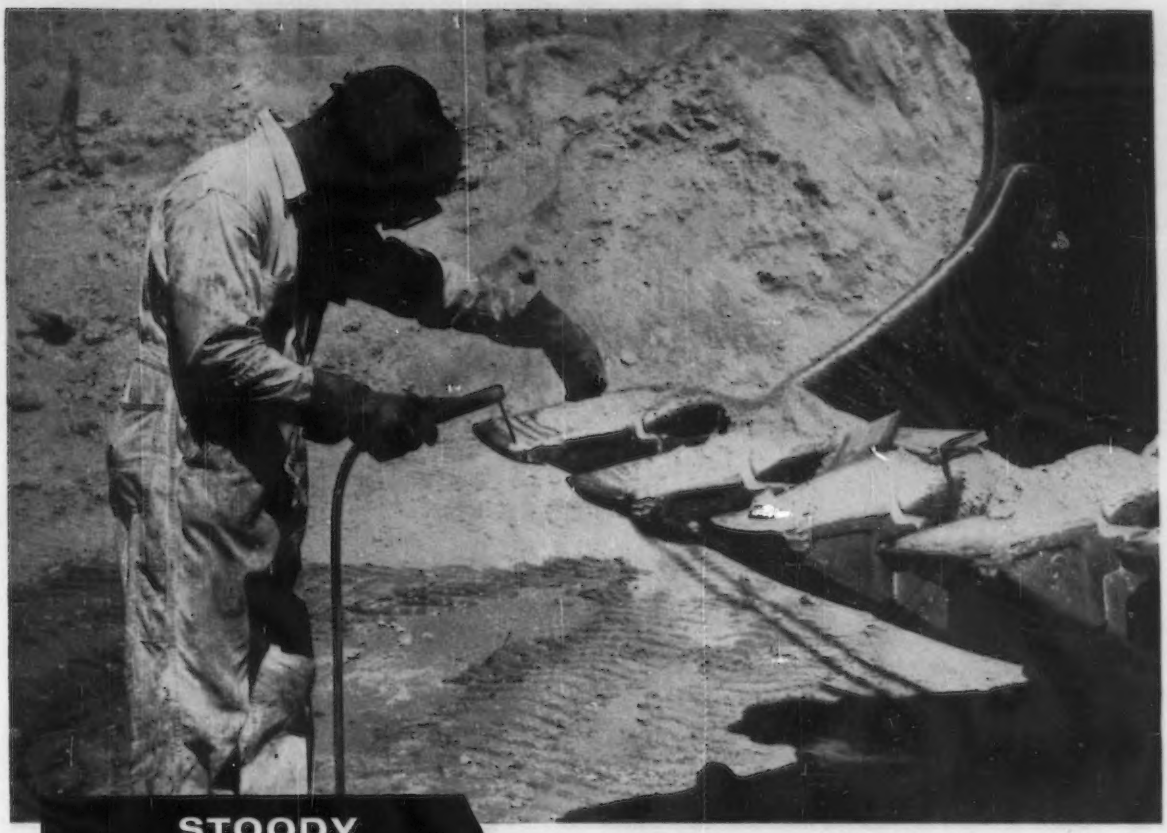
On Oct. 30, president R. T. Elstad of Oliver Iron Mining Div. announced that Oliver would begin the construction of a new beneficiation plant as soon as the strike is over. The new unit will be located adjacent to the present Sherman group ore screening and sizing plant and operated in connection with it. It will be designed to handle the low grade ores of the Monroe and Sherman groups and will include a complete washing plant with scrubbers, heavy media and spirals. It is expected to be ready for the 1961 season and will produce about 1.5-million tpy concentrates.

MONTANA

S. E. Jerome, northwest district geologist at Spokane for Bear Creek Mining Co., said the Kennecott Copper Co. subsidiary has staked a large number of mining claims near Philipsburg. He said the firm located about 100 claims five to 10 miles southwest of Philipsburg this summer for an investigation of copper mineralization.

NEVADA

Three miners were killed in the Mohawk mine east of Silver Peak in Esmeralda County Oct. 13 when timbering gave way and a rock fall trapped them at the 300 level. They were Samuel Sickels, of Tonopah, James Roberson, of Mina, and William DeLorme, of Redding, Calif. Rescue work was carried on by 50 miners working around the clock on three faces of the 300 level, but on Oct. 29 the search was discontinued when there was no more hope of finding the men alive. The mine had recently been reactivated by the U.S. Milling & Minerals Corp., and rescue efforts were headed by Sam Levine, president of the company. Kennecott Copper Corp. sent six rescue experts from Ely and U.S. Vanadium sent 10 men from Bishop. Emil W. Felegy, district supervisor of the USBM was present from San Francisco, along with Mervin Gallagher, Nevada mine inspector, from Carson City, and Leonard Traynor, Gallagher's deputy, from Tonopah. The Sandia Corp. furnished a generator and camping equipment was furnished by Air Force installations at Fallon and Tonopah. A Tonopah physician was on hand to treat any of the rescue squad that needed his attention. The cave-in blocked the tunnel for a distance of more than 300 ft, and all of it had to be retimbered before it could be entered. Following the end of the search, regular shifts resumed work at the mine and



TUBE BORIUM *is applied to areas of concentrated wear, such as teeth, for maximum wear protection.*

STOODY SEMI-AUTOMATIC HARD-FACING + TUBE BORIUM

where the going is toughest!

STRINGER BEADS *of Stoody 121 and Stoody 100 applied semi-automatically keep buckets in good condition.*

Usual maintenance procedures just couldn't keep buckets and teeth in shape on this job...wear was too severe. The answer was found in the semi-automatic welder applying Stoody 121 and Stoody 100 to bucket lips, sides, and runners, and to teeth and adapters.

But even then, teeth needed additional protection. To keep them digging efficiently, points were treated twice a day with several beads of Stoody Tube Borium, using manual electrodes. Tube Borium is the "last word" for protecting earth-working equipment where the going is toughest. A few beads virtually form a layer of pure tungsten carbide—your assurance of maximum wear.

Have you investigated the semi-automatic welder and Stoody hard-facing wires in your own operations? Stoody dealers (consult the "yellow pages" of your phone book) are glad to demonstrate the machine in your own plant. Write for details.

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11930 East Slauson Avenue • Whittier, California

this is the BUSINESS END of your dragline

choose it carefully!

The BUCKET can make the difference in profits you earn on a major investment — your dragline! Take a look at the extras built into every Bucyrus-Erie dragline bucket:

A special alloy steel is used in Bucyrus-Erie buckets! Called BECOLOY, it is a hard, tough steel that can stand impact. It is shock resistant, withstands abrasive material, yet readily lends itself to welding.

Bucyrus-Erie buckets also have unusual surface hardness to withstand continuous abrasive wear. They have withstood thousands of hours of the toughest digging and *still continue to produce!*

Don't jeopardize your selection of a dragline with a poor choice of buckets! Get the full story on Bucyrus-Erie buckets from your distributor or Bucyrus-Erie representative today, or write Bucyrus-Erie Company, South Milwaukee, Wisconsin, Dept. 5RB.

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Nevada *(Continued)*

are now clearing out the rubble preparing to put the 300 level back in working condition.

Minerals Refining Co., of Murray, Utah has started exploratory work at its placer mine on Willow Creek, 25 miles southwest of Winnemucca, following a shutdown of mining operations for the winter. During the previous five months, 35 men were employed handling 75 tpd of gravel. The mining was by open pit and a power shovel and two bulldozers were in use at the site. Ore was hauled to the company's mill two miles down stream where the gravel was sent through two large jigs, Humphrey spirals and cleaners. Final recovery was made with mercury. Housing was furnished at a trailer camp half-way between mill and mine, and Pershing County built a wide gravelled road from the pavement toward the mill site, for a distance of six miles. E. F. Fenner, Salt Lake City, is general manager and says full-scale mining operations will be resumed in April. He is also in charge of exploration.

A new strontium variety of meta-autunite, one of the major ore minerals of uranium, has been isolated by Dr. Aledsis Volbroth, mineralogist with the Nevada mining analytical laboratory of the University of Nevada. Dr. Volbroth said his study clarifies the difficult question of the size of the unit cell and water content of meta-autunite in relation to autunite.

USM&M is operating the Ohio mine at Gold Point in Esmeralda County where 10 men are producing 50-tpd gold ore under supervision of Harry David; and the Tonopah King mine at Tonopah where 12 men under superintendent J. Martinez are producing about 45 tpd.

US Milling & Minerals Corp. has completed construction of a large addition to the sulphur dioxide leaching process equipment at its mill in Silver Peak. The new equipment enables the mill to handle silver ore from the Mohawk mine which was recently acquired by the company. More than 3,000 tons of Mohawk ore averaging between 38 and 41 oz silver were stockpiled before the cave-in on Oct. 13, and the mill was handling 150 tpd.

Reopening of the Kaiser Co.'s steel mill at Fontana, Calif., late in October resulted in resumption of iron mining activities on the part of several firms in Mineral Basin southeast of Lovelock on the Pershing and Churchill County lines.

Nevada's mining industry showed a healthy increase during the summer of 1959, according to employment statistics. During June 4750 men were employed in Nevada's mines as compared with 4156 in June of the previous year. July employment in the mines was 10.3% above the totals for July, 1958. The figures do not include the owner-operators of many small mines in the state, according to Mervin J. Gallagher, Nevada mine inspector.

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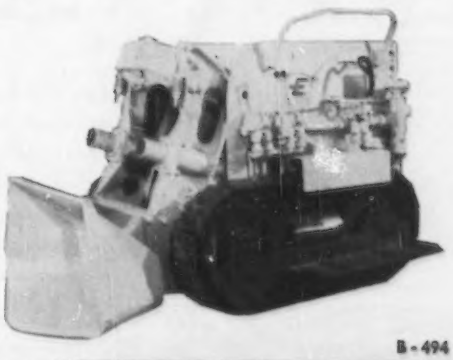

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Nevada (*Continued*)

Following completion of a new power line and installation of transformers and wiring, the Tonopah Divide mine shaft near Tonopah has been reopened by the Big Divide Mining Co. New equipment has been installed for development of the property. The company is also operating two shifts at the Big Divide mine on Gold Mountain, six miles south of the Nye County seat and is producing a good grade of silver ore.

Belmont Mines Co. after four months of work has almost prepared the Eldorado South mine in Nye County for production. Work started in May with a small crew working under direction of Walter Simmons, of Kingman, Ariz. A steel headframe was erected, a new hoist installed, a 100 kw diesel generator installed, the shaft was retimbered to the water level, a distance of 150 ft, and an Ingersoll pump with 500 gpm capacity was installed. Starting July 15 three shifts were employed and operations began on a 24-hour basis with a crew of 15 men. Stations were retimbered and the bottom of the 450-ft vertical shaft was reached early in October. The inclined shaft to the surface will next be opened for ventilation and safety.

NORTH CAROLINA

Cranberry Magnetite Corp. of Cranberry, N.C., has obtained a 38-year lease on the old Cranberry Iron mine, which has been reopened to produce ore for blast furnace uses and a high grade magnetic concentrate used in heavy media coal-washing plants and electric furnace production of high grade alloy.

Principals in the new firm are Sidney A. Montague of the Spruce Pine Mica Co., Spruce Pine, N. C. Dixon of the Appalachian Exploration Co. of Cranberry; J. W. Hunicutt and Lawrence E. Larkey, both of Elizabethton, Tenn.; Brown Porter of Statesville, L. E. Dimmette of Lenoir, and Dr. Claude A. Frazier and Dr. C. Don Gerdes of Asheville.

Upon recommendation of its minerals resources committee, the North Carolina state board of conservation and development on October 27 ordered a survey of asbestos deposits in North Carolina. Dr. Jasper Stuckey, state geologist, said there are known deposits of short fiber asbestos in the North Carolina mountains but that the extent of the reserves is not known.

During the first seven months of 1959, the Foote Mineral Co. carried out a program to redefine the lithium ore reserves at its Kings Mountain property. As of July 1959, the measured ore totaled 20,746,297 tons averaging 1.53% Li_2O. This measured ore reserve is 55% higher than any previous estimate reported to shareholders. Although not yet fully proven, an additional reserve of 15,769,075 tons is indicated in adjacent ground. The total measured and indicated ore reserve of 36,515,372 tons is 30% higher than any previous estimate.

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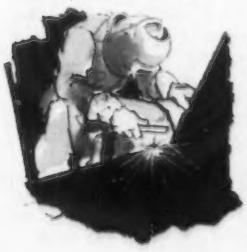

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OREGON

More than 500 delegates and wives are expected to attend the 13th annual 1960 Pacific Northwest Metals & Minerals Conference of AIME to be held in Portland, Oregon, next April 28, 29, 30. There also will be sessions with American Society of Metals.

Conference site will be Portland's new Sheraton hotel.

Hollis M. Dole, director, Oregon department of geology and mineral industries, is general chairman. John R. Anderson, product engineer, Carborundum Co., Vancouver, Washington, is co-chairman. Other members of the conference committee include Gordon White, superintendant of the Reynolds Metals Co. reduction plant at Troutdale, chairman of activities and arrangements; Jens Thorjorsen, Reynolds processing engineer, entertainment, Richard Hanson, Reynolds Carbide plant superintendent, facilities; Robert Hall, Reynolds process engineer, printing and programs; George Stout, Aluminum Co. of America works manager, Vancouver, Wash., finance; Clifford Glover, assistant manager, Pacific Carbide, Portland, budget; and Joseph Tauscher, process engineer, Reynolds Metals Co., assistant registration and Ralph S. Mason, mining engineer, Oregon department of geology and mineral industries, publicity.

SOUTH CAROLINA

Streams between Aiken and the Atlantic coast have untapped sources of heavy minerals which may be "worked commercially in the not-too-distant future," according to Dr. Eugene S. Perry, professor of geology at the University of South Carolina.

Dr. Perry says titanium, zirconium, monazite and other heavy minerals are available in richer supply than in locations now being mined. Minerals containing titanium, zirconium and thorium are found in many or most of the streams between Aiken and Columbia, as well as along the coast, and with improvements in the metals market it is probable that some of the known deposits will be worked, reported Dr. Perry.

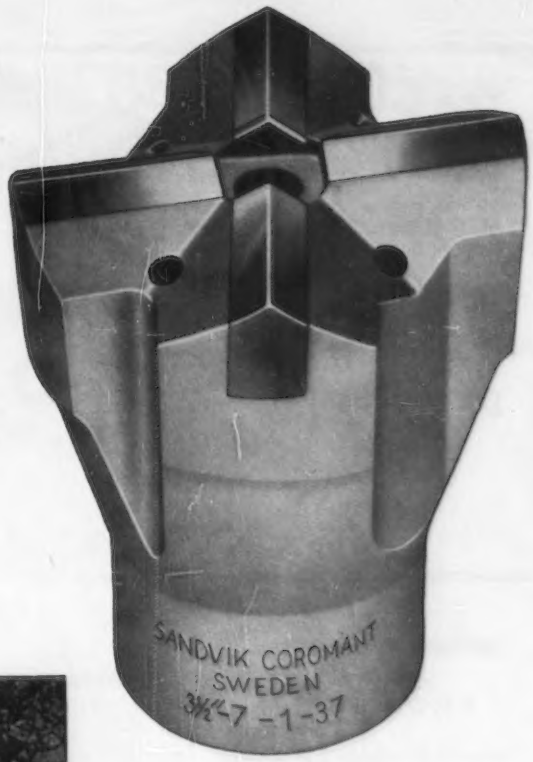
Dr. Perry was head of the geology department of the Montana School of Mines for 27 years and chief geologist of the Montana Bureau of Mines for 25 years. He is considered to be an authority on mineral resources.

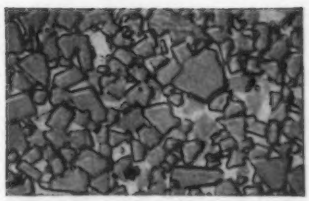
TENNESSEE

With the exception of American Manganese & Sulphate's Clear Creek mine, the Tennessee manganese district, centered around Elizabethton, has been closed down. Almost all manganese ore produced in the district had been going into the Government stockpile. Buying for the program ceased earlier in the year.

The recent increase in the price of zinc has spurred the already fast growing East Tennessee zinc district into even greater production. Most of the mining

Longer bit life— with *new* Sandvik Coromant Bits





Sandvik Coromant Tungsten Carbide (Microphoto) Uniformity of size, even distribution of grain are marked. Free from porosity and impurities —therefore stronger, longer-lived.

Low quality Tungsten Carbide (Microphoto) Black marks are contaminations caused by deficient production control. They weaken the carbide, reduce its working life.

NEXT time you buy bits, specify Sandvik Coromant because they give more footage per bit, lower drilling costs. Here's why:

1 Only first-quality tungsten carbide is used —as shown in the microphotos above. This means less wear, longer life and a better job.

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3 The bigger Sandvik Coromant bits are all of X-design, which prevents rifling. No wonder Sandvik Coromant inserts are the most widely used in the world, drilling more than one billion feet every year.

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SHOULDER	TAPER	x	x	x	x													
	F		x	x														
	113		x															
	H			x	x	x	x	x		x								
	115			x	x													
	D						x	x	x	x	x	x	x	x				
	K													x	x	x	x	
BOTTOMING	1" Rope				x	x	x	x		x								
	1¼" Rope						x	x	x	x		x		x				
	400						x	x		x		x						
	1½" Rope											x	x	x	x	x		
	600											x	x	x	x			
	700													x	x			
	J 7.5															x	x	
	2" Rope														x	x	x	x
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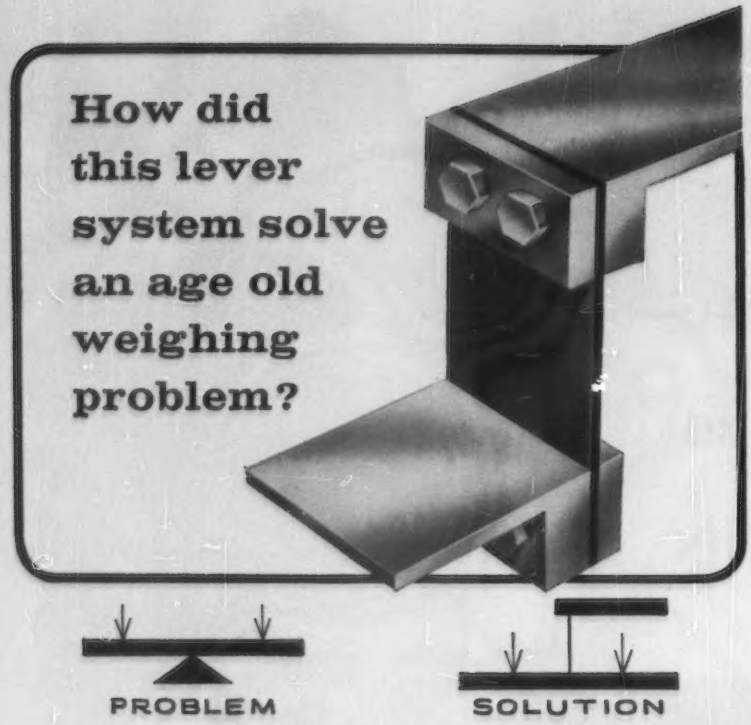

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The problem was solved in 1956 when the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen aware of industrys tremendous cumulative loss of materials in weighing operations, had devised a revolutionary new scale.

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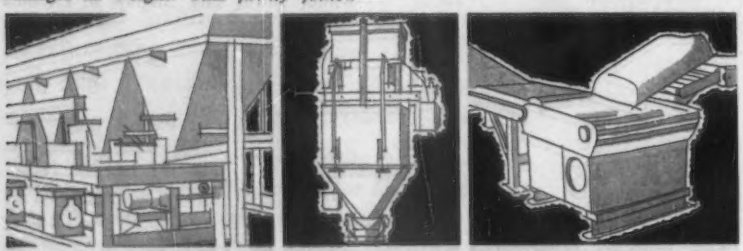
Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.



THAYER SCALE

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THAYER SCALE CORP. THAYER PARK PEMBROKE, MASS.

For further information see Page 599 of the new Chemical Engineering Catalog.

Tennessee (*Continued*)

companies are actively planning to increase output of zinc ore from individual mines. Observers think that the current 10,500 tpd rate of mining for the district may be increased as much as 15% in the next few months.

UTAH

Calera Mining Co. will cease operations by Nov. 1 at its Garfield cobalt refinery, according to F. A. McGonigle, vice president of Howe Sound Co., New York. Calera is a wholly-owned subsidiary of Howe Sound. Mr. McGonigle said the cobalt refinery and copper-cobalt mine at Cobalt, Idaho, built at cost of $12-million, would be closed as a result of OCDM's failure to certify import restrictions on foreign-produced cobalt following a hearing on the issue in Washington.

Western phosphate industry, which has out-stripped developments in eastern parts of the U.S. since 1944, will continue its rapid growth, according to G. Donald Emigh, St. Louis, Mo., director of mining for Monsanto Chemical Co.

Mr. Emigh said in a speech before civic leaders at Salt Lake City in October that "only 30% of the phosphates produced in the West are used in the West. But since 1944, the Intermountain West has increased its production eight times while output of phosphate rock in the rest of the nation has only doubled.

"The electric furnace has been the prime factor in increasing the output of phosphate rock during the last 12 years," Emigh said. "Four plants located in Idaho and Montana use two-thirds of the phosphate rock produced in the West."

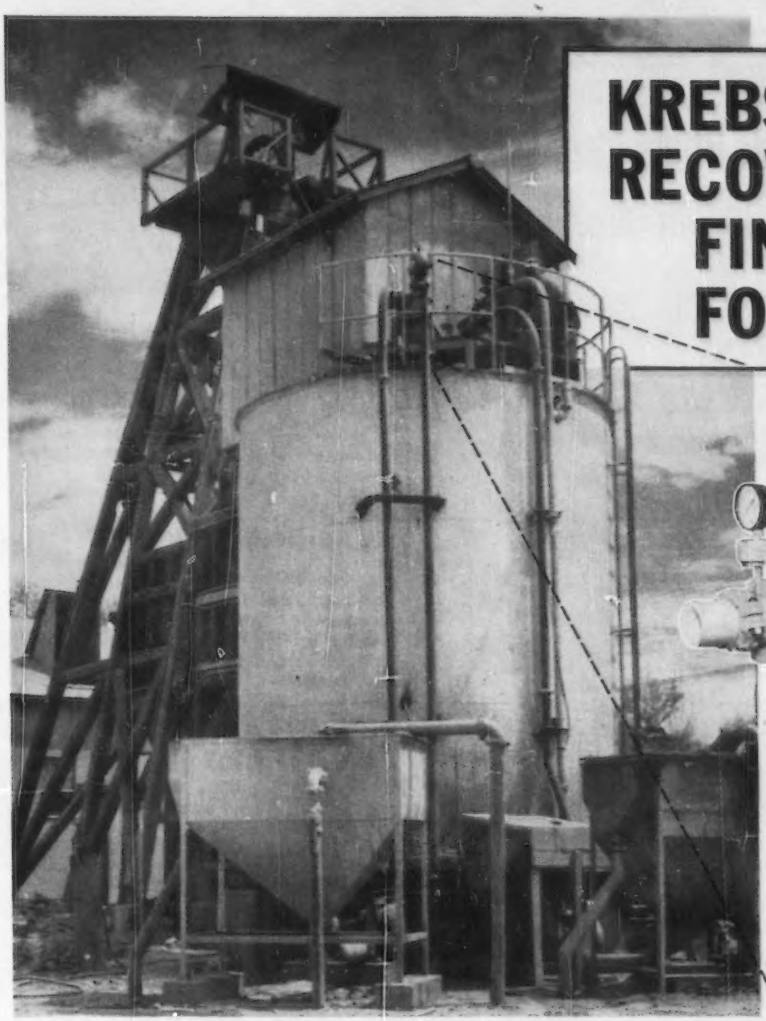
He predicted a continued increase in phosphate mining, with emphasis on deposits in northern Utah, now either coming into the mining stage or scheduled for mining.

A new phosphate-leasing drive on a north branch of the Uinta Mts. of northeastern Utah is underway. Those who have staked claims on properties to date say they plan development of the phosphate in connection with the energy to be made available three years hence from Flaming Gorge dam. That is the same program envisaged by Stauffer Chemical Co. with affiliated San Francisco Chemical Co. at the huge Humphreys deposit, 15 miles north of Vernal and about 65 miles from Flaming Gorge Dam.

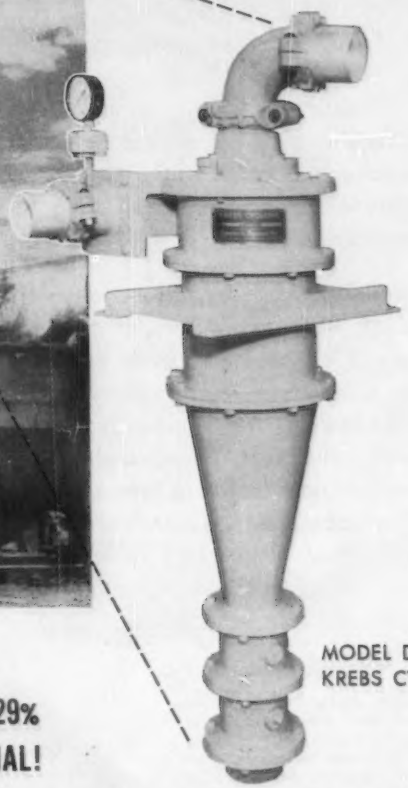
The new lease area, in which John H. Morgan Jr. and Sr. have leased 3,000 acres in state and Federal acreage, is located in Townships, 2 North, Range 20 East.

On December 9 and 10, Mike and William Abraham, Dallas oilmen, have requested that packets of 2,509 acres and 2,373 acres respectively be placed up for competitive bid. The Morgans recently beat the San Francisco Chemical Co. in a competitive bid affecting 1,806 acres on what will some day become

KREBS CYCLONES RECOVER 80% OF FINE TAILINGS FOR MINE FILL



Installation at Banner Mining Company Copper Operation near Tucson, Arizona



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SIZING—	FEED	OVERFLOW	UNDERFLOW
% +100	4.9		6.2
+150	10.2		13.0
+200	12.7		16.2
+325	25.2		32.2
−325	**47.0**	**100.0**	**32.4**

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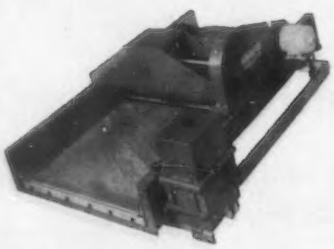

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Utah *(Continued)*

the shore of the lake created by Flaming Gorge Dam.

VIRGINIA

Expansion of mineral mining operations in an 800-acre tract at Hanover County, has been announced by James L. Oberg, general manager, metals and minerals division, Metal & Thermit Corp.

According to Mr. Oberg, "a program to develop the two-year-old Hanover property has proven that substantial quantities of aplite are present in the orebody." Aplite is one of a group of minerals used by the glass industry as a source of alumina for the production of colored and flint containers and window glasses.

WASHINGTON

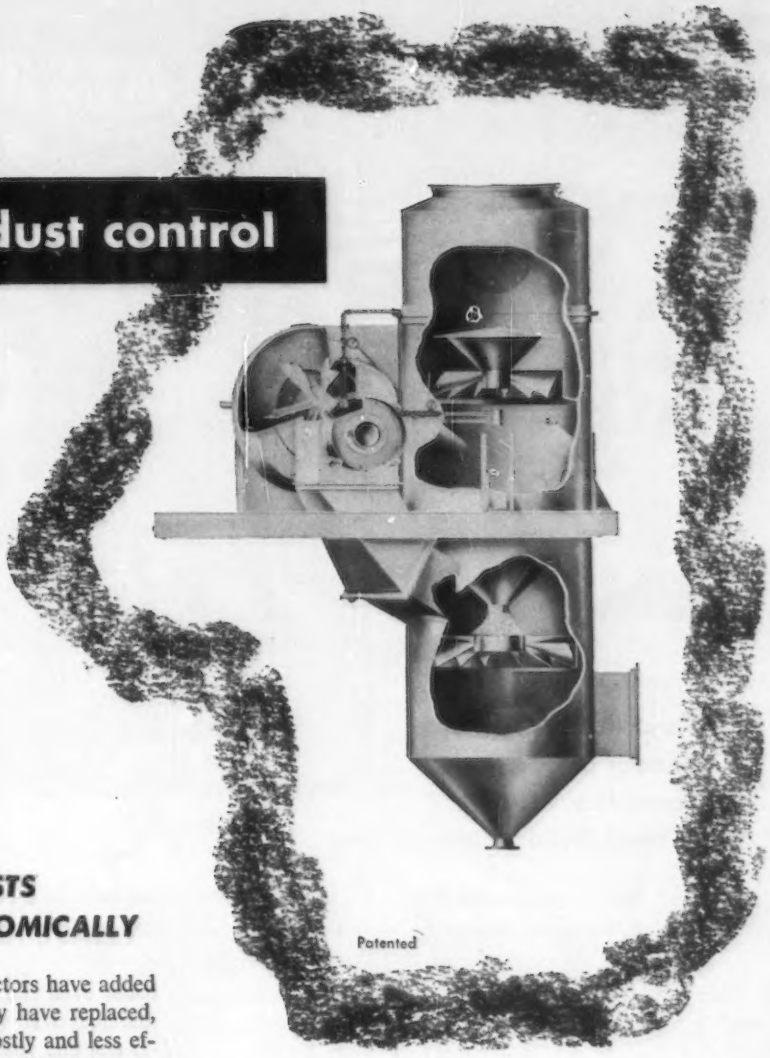
Spokane National Mines, Inc., Spokane, has purchased the Bannack gold mine and the New Departure silver mine, both located southwest of Dillon, Mont., according to George Alison, president. A mill at the gold property will be modernized to handle about 100 tpd and it will go into operation in November, he said. About 1500 tons of ore are in stockpile and another 15,000 tons of ore have been estimated as available at the property. A 150-ton flotation mill will be installed at the New Departure mine, where officials said about 200,000 tons of ore are available for mining. Both properties were acquired from C. G. Miller, of Dillon.

Northwest Magnesite Co.'s Chewelah plant (in Stevens County, north of Spokane) planned to start another kiln at the plant by about Dec. 1 to meet steel industry orders for dead-burned magnesite. The firm put its big rotary kiln back in operation Oct. 21 in anticipation of an early end to the steel strike. Howard Ziebell, manager, said the firm expects a heavy demand for its output in open-hearth steel furnace operations. Production had been suspended in July.

Big Iron Mining Co., Spokane, has released its holdings in northern Stevens County, to Dean Koethke, Kellogg, Idaho, who plans to start open pit iron ore mining operations there next spring. Officials of Big Iron said the property, near Orient, was last operated in the 1930's, when ore was shipped to Chewelah for handling. The property consists of 220 acres with 11 unpatented mining claims.

Utahcan Mines, Inc., of Spokane, has shipped its first zinc concentrate—60 tons—to the Bunker Hill zinc plant at Kellogg, officials said. Roy Lorang, president, said the concentrate was made in the firm's new concentrator in the Jim Creek mining area northwest of Ione. The concentrator went into production recently after two months of testing. The Spokane firm hopes to go on an around-the-clock milling basis soon and treat 100 tpd or more.

. . . in wet dust control



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Ducon UW-4 Dynamic Wet Dust Collectors have added a new dimension in dust recovery. They have replaced, with outstanding success, many more costly and less effective dust collectors in the recovery of "difficult" materials, such as fine and abrasive dusts in kilns, rotary driers and other applications.

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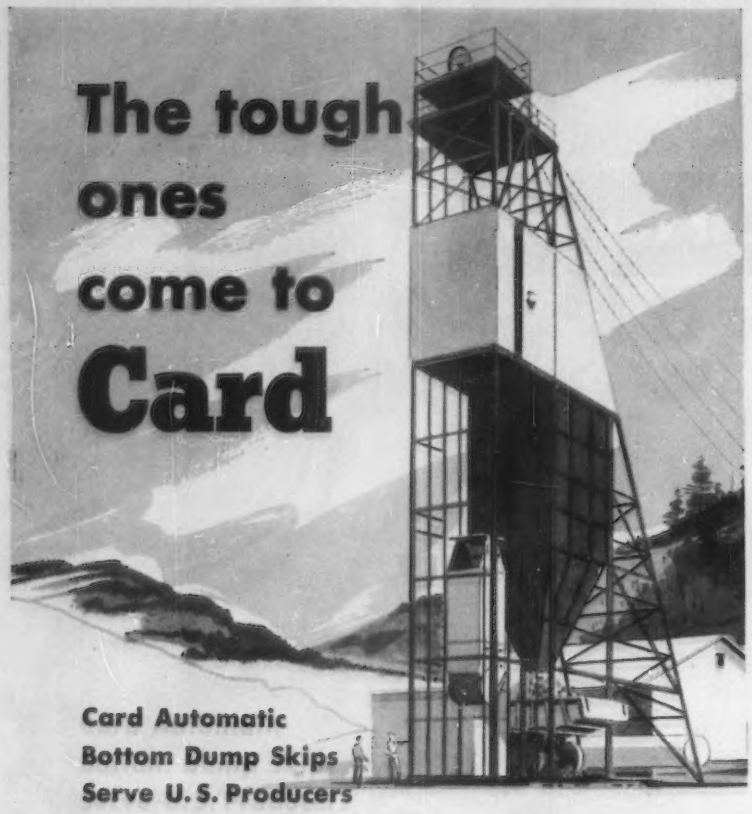
CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES



Card Automatic Bottom Dump Skips Serve U. S. Producers in most Major Mining Areas

This is a progress report on a relatively new idea. Beginning in 1956, increasing demand for the new Card automatic bottom dump skips has gradually brought them into service in a majority of the nation's principal mining areas—from Arizona to the Canadian line. In a typical operation two of these Card skips of approximately 150 cu. ft. capacity each are used to haul ore up a thousand-foot three-compartment shaft at a rate in excess of 900 tons per day.

In the initial year of operation, in one such installation, these automatic skips carried over 270,000 tons of rock before needing attention other than routine maintenance. The same successful design will prove out in your next project. It can be adapted to any capacity and specifications with ease.

Tell us your requirements.

C.S. Card Iron Works Co.

2501 WEST 16th AVE., DENVER, COLORADO

Washington *(Continued)*

Northwest Prospecting & Development company, Spokane, started a drilling program in October at thorium properties on Hall mountain near Bonners Ferry, Idaho. A drilling contract has been let to Herb Sams of Elk, to check the size of an orebody exposed by bulldozing.

Bear Creek Mining Co., a subsidiary of Kennecott Copper Co. reported at its Spokane office that a 40-man crew has completed four months of diamond drilling and development work at the Glacier Peak copper property in the Cascade mountains in Snohomish County.

S. E. Jerome, northwest district geologist in charge of the office, said that drilling work was carried out at the property under contract by E. J. Longyear Co., Minneapolis. In addition, the firm did geological, geophysical and geochemical work at the site and located some additional claims.

WYOMING

Lucky Mc Uranium Corp. is experimenting with use of direct roasting of sulphur in an ore-drying kiln to reduce sulphuric acid use. While pyrites have in past been employed in similar fashion in some Uravan Mineral Belt mills, this is first instance of sulphur values themselves being used, report observers.

Lucky Mc has wet ore from open pits in Gas Hills district which is dried to facilitate rough grinding. The firm has not released details of process or amount of acid saved, which some report as high as 20 tpd.

Nine companies using silica sand have been contacted about the feasibility of developing large deposits of silica sand in the Greybull area. O. O. Waggener, industrial director for Chicago, Burlington & Quincy railroad, said the 25-ft thick sand deposits could be quarried and transported at a minimum cost.

IN CANADA

BRITISH COLUMBIA

Officials of British Columbia and Yukon chamber of mines predict a prosperous year for 1960 with an all-time record in prospecting and exploration.

Department of mines reports the number of claims staked up to Aug. 31 totalled 9,200, down slightly from the 9,700 staked in the same period last year, and only a third of the 1957 total of 26,170. Spokesmen for the mines branch, however, point out that exploration activity is holding up surprisingly well this year, considering depressed metal markets and tight money conditions.

Tom Elliott, secretary of the Chamber, points to some of the signs which he interprets to mean better conditions

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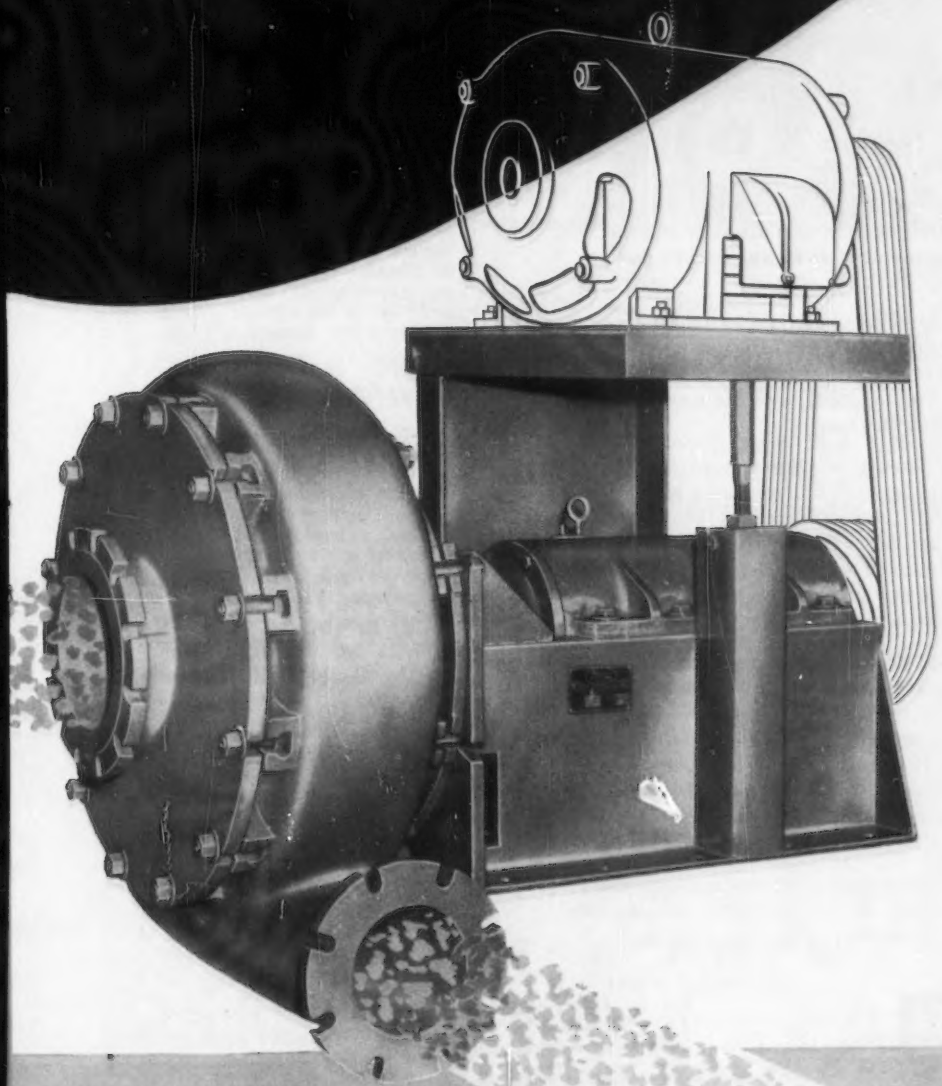

Hydraulic movement of materials can be simple, if you think in terms of a Morris Type CK Pump. A heavy-duty pump, with extra-wide clearances to handle larger random sizes, the Type CK is available in 4", 6", 8", 10", and 12" sizes. Engineered and constructed for long wear and resistance to abrasion and corrosion the Morris CK is available in semi-steel, ni-hard, cast steel or stainless alloys.

With the CK Pumps' low internal velocity, you get less turbulence, less abrasion, less wear and lower power costs. The Type CK features ease of maintenance, with extra clearances provided for easy replacement of packing . . . impeller readily accessible for inspection.

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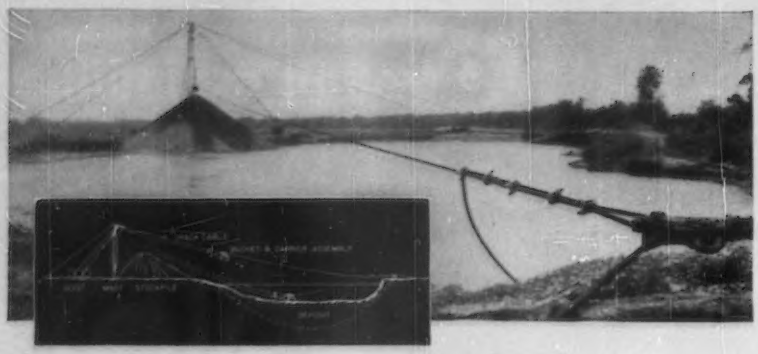

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DIG and HAUL for
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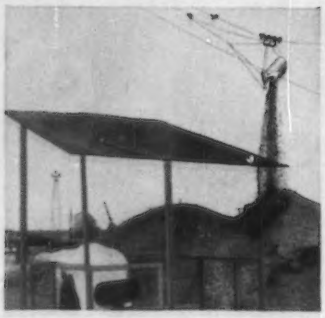

Operating costs as low as 8¢ per yd. for labor, power and maintenance are reported by Slackline Cableway owners when digging free-caving material at average depth and haul distances.

These low costs are achieved by using just one machine—the new Sauerman Slackline Cableway. Multiple equipment is not needed to supply your required tonnage. For example, on an average haul and digging depth, a single medium size machine will charge a 200 tph. plant.

The high Slackline mast permits building a large pile which can supply plant demands through a plate feeder and tunnel conveyor, front-end loader or clamshell. The new Sauerman torque converter diesel-hoist automatically matches power to load demands and is designed for continuous duty. Fluid drive cushions out shock loads to reduce fuel and maintenance costs, extend cable life.

Increasing land values and depleting resources make it necessary to get all the material out of your deposit. You can do this with a Sauerman Slackline. The machine will dig from ground level to deep under water and keep your plant running additional years at the lowest possible operating cost. Several pits are now operating Slacklines on 1000-ft. spans with average hauls of 500 to 700 ft. and from 100-ft. depths.

Write or call, giving your tonnage requirements, depth and length of deposit—if available. We will promptly supply more information on Slackline Cableways, and show you how to *save with a Sauerman.*

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B.C. *(Continued)*

ahead: Several big mining firms are showing renewed interest in B.C. (These firms reduced or cancelled exploration programs there because of new mining legislation in 1957. Some of the objectionable features of the laws were subsequently removed); most of the major companies are now represented in B.C.; their exploration programs are long-range, and often this indicates the companies feel confident of the future.

Statehood for Alaska and Wenner-Gren plans for the Peace River have centered attention on the northwest, and companies that sense the industrial potential of the area want to be in on the ground floor.

Silver Standard Mines will proceed to put its iron properties on Moresby Island into production, according to R. W. Wilson, managing director. Expenses include a dock, road, plant and stripping of 760,000 yd of overburden. The property has proven 1.5-million tons of iron ore. A second diamond drill has been sent in to step up exploration.

Wilson said an agreement has been reached with the provincial government which allows Silver Standard to ship at least 600,000 tons of iron (1-million tons of concentrate) to Japan from claims issued after Jan. 19, 1951. The area within five miles of Harriet Harbor will not be declared a "producing area" for taxation purposes.

Bralorne Pioneer Mines Ltd. reports production is down sharply because milling of Pioneer ore was curtailed (in order to experiment with the milling of Bralorne ore at the Pioneer cyanide mill), and there was shortage of labor.

NEWFOUNDLAND

Maritimes Mining Corp. is back up to full production following curtailment in the third quarter due to power failure. The mill is treating around 2,000 tpd, up from an average of 1,900 tpd in the September quarter. Monthly production at the Tilt Cove property on Notre Dame Bay is running slightly over 2-million lb copper.

NEW BRUNSWICK

Chesterville Mines is diamond drilling to test for extensions of indicated ore on its recently acquired property in the Bathurst area. In previous work by Kennco Explorations some 2-million tons grading 2% copper was outlined in several shoots in a strong structure. The estimates are calculated to depth of 800 ft with the zone still open to depth.

Underground work is continuing at the Consolidated Mining & Smelting Co.'s Wedge copper property, some 28 miles southwest of Bathhurst. The project, estimated at cost of $1.4-million, calls for lateral work on the 500-ft and 900-ft levels. Initially the shaft is to extend to 1150 ft.

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Many brands of rope *look* alike but the rope you buy must pay off in *performance*, not *appearance*. With Wickwire Rope you get a number of quality factors that lead to outstanding performance. These factors are "built-in" the rope through many quality controls and tests. Since CF&I performs all steel producing, wire making and rope fabricating operations within its own plants, exacting control and testing procedures can be carried out and supervised at every step. Here is just one of these procedures:

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Samples are cut from both ends of every coil of wire and given complete physical tests — for tensile strength, roundness, torsion and uniformity of diameter. Coils that fail any test are rejected for such critical applications as wire rope.

We have recently printed several folders that discuss many more Wickwire control and testing procedures, plus wire rope recommendations for specific equipment. To get a copy, contact the nearest CF&I sales office—but please *state your industry or type of equipment.*

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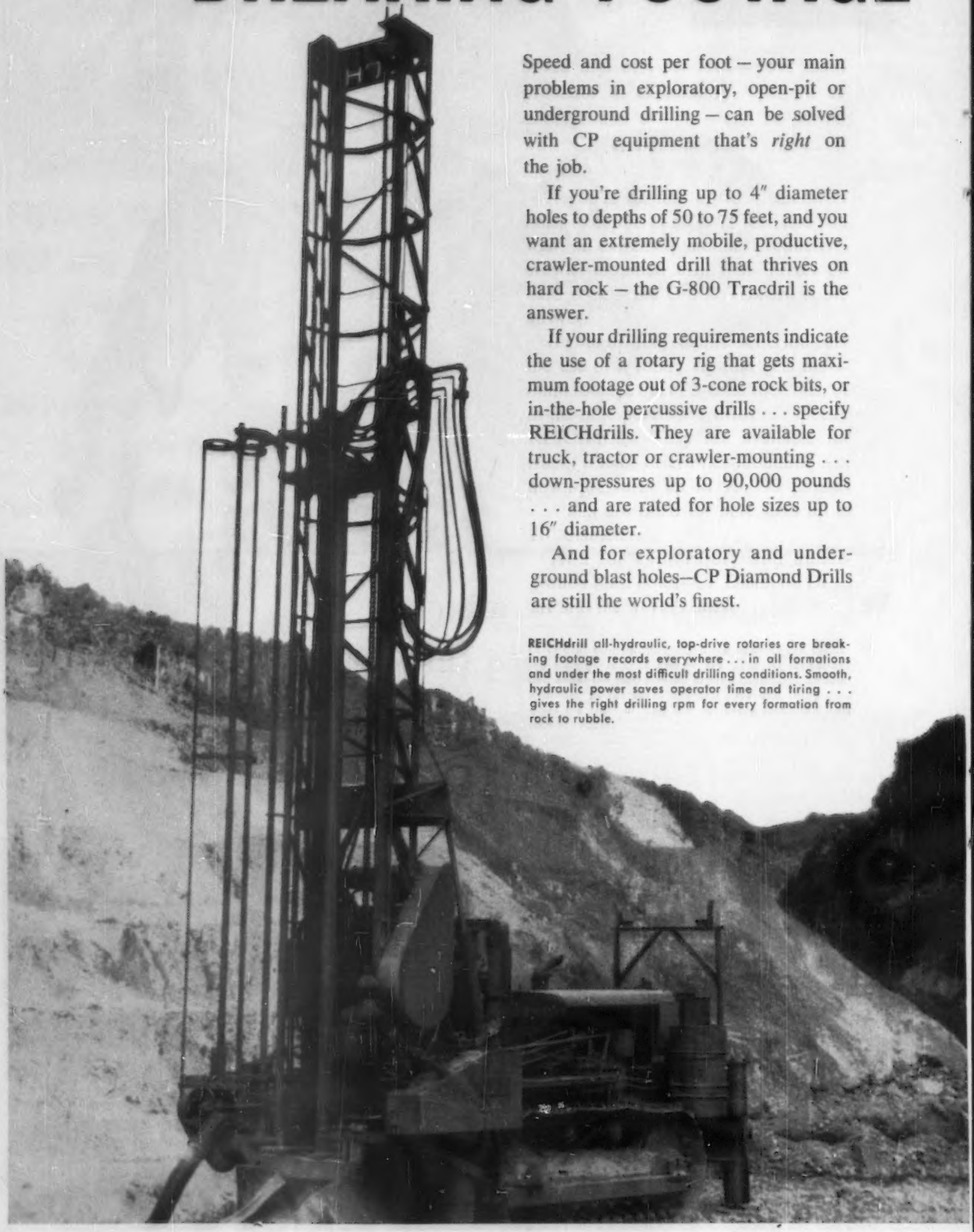

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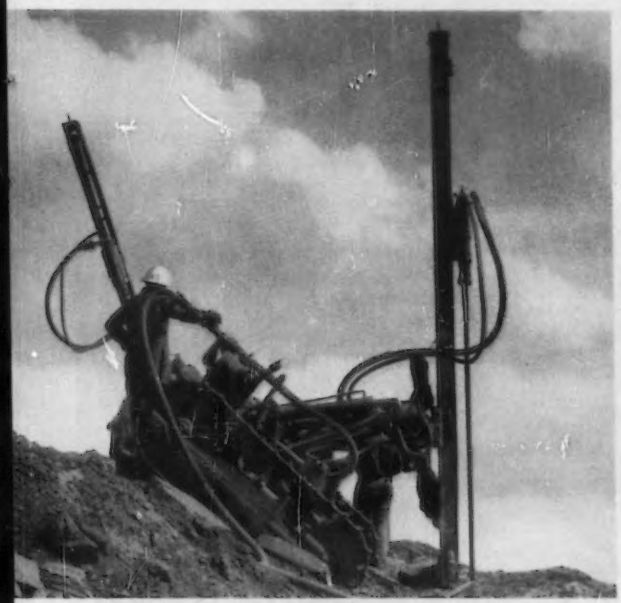

G-800 TRACDRIL, a really hard-hitting percussive drill. Uses 4½" bore Deep Hole Drills — capacity to 75 feet. Good for really bad ground and hard rock. Automatic brakes take hold the instant traction motors are stopped . . . prevent inching . . . insure safety.

CP-600 "POWER VANE" ROTARY COMPRESSORS, shoulder-to-shoulder, or singly, keep air-driven drills slugging 'til you tell 'em to stop. Capacities from 125 to 900 cfm, gasoline or diesel engine drive.

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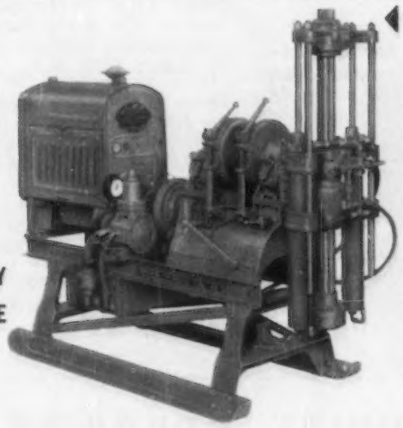

CP-8HD, is exceptionally easy to handle — mounted on skids for easy movement from hole to hole under its own power. Capacity: with EW-EX fittings — 1250 feet. Gas, Diesel, or Air drive.

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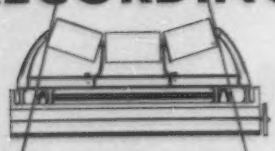

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NORTHWEST TERRITORIES

A full-fledged drive is underway to stake base-metal claims in the Great Bear Lake area. More than 1,500 claims have been staked recently in the area immediately east of the lake and mining recording officials state another 1,000 will have been staked by year-end. Good grade deposits of copper and molybdenite are indicated.

NOVA SCOTIA

Wadge Mines has extended the length of the main gold vein in diamond drilling on its Logan property at Lake Charlotte. Shallow drilling has established continuity of structure for a length of 300 ft. High grade gold values have been obtained and drilling is being continued. Plans are being concentrated on determining full length of the vein prior to tests at depth.

Conwest Exploration is diamond drilling to follow up a promising new zinc discovery on its 64-claim property at Bras d'Or Lake on Cape Breton Island. Widespread mineralization of clean sphalerite has been located in crystalline limestone formation. Additional ground is being sought and several other companies including Anthonian Mining Corp., Consolidated Mining & Smelting and Consolidated Negus Mines are said to have taken up property in the area.

ONTARIO

Can-Met Explorations has come into difficulty at its uranium producing mine in the Elliot Lake area. Formations have been encountered in underground development which have cut off large tonnages of ore, reduced grade in other sections, and yielded ore requiring more extensive treatment. The structures were not revealed in the limited diamond drilling completed prior to decision for production. Present plans to continue milling at rate of 2,600 tpd for a few months.

Ontario gold production for the first nine months, 1959, totaled 1,957,978 oz, against 1,975,112 oz for the like period, 1958. Tonnage milled amounted to 6,884,256 tons, compared with 6,937,246 tons. The number of producing gold mines in the province has remained constant at 30.

Campbell Red Lake should chalk up record production for 1959 as grade continues to rise at its Red Lake area gold producing property. In the first nine months of the year output amounted to $4,110,413, up from $3,828,576 in the corresponding period of 1958. Tonnage milled was 192,953 tons against 191,494 tons, while grade moved up from $19.99 to $21.30 per ton. Average grade for the full 12 months, 1958, was $19.84 per ton.

Kerr-Addison Gold Mines is heading for another record production year. Output from its gold mine in the Larder Lake area for the first nine months was $14,444,268, up from $13,551,927 in the like period of 1958, which was also a record year. During the period 1,243,961 tons were milled for recovery of $11.61 per ton, compared with treatment of 1,243,123 tons for recovery of $10.90 per ton in the first nine months of 1958.

New Mylamaque Explorations has entered into an agreement with Koppers Co. of Pittsburgh, Pa., for the design and engineering of a smelter for its iron property near Newboro. Final decision as to size of the plant has not been made yet but plans are being drawn up for capacities of 100,000 and 200,000 tons of pig iron or semi-steel per year. Extensive concentrating tests have been carried out at Ottawa and Lakefield and smelting tests at the Strategic-Udy metallurgical and chemical processes plant at Niagara Falls, N.Y.

Dome Mines, veteran gold producer of the Porcupine area, is maintaining production on a par with that of last year. Output for the first nine months, 1959, amounted to $4,368,064 from 534,700 tons milled, an average recovery of $8.17 per ton. In the corresponding period, 1958, output totalled $4,382,263.

Siscoe Metals' production this year is running at the highest rate in the his-

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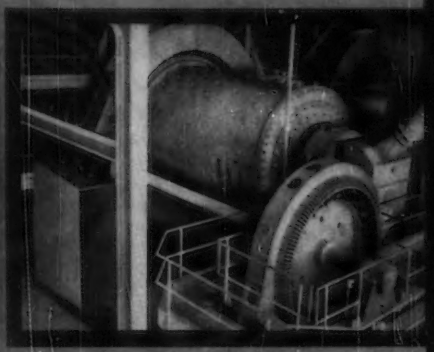
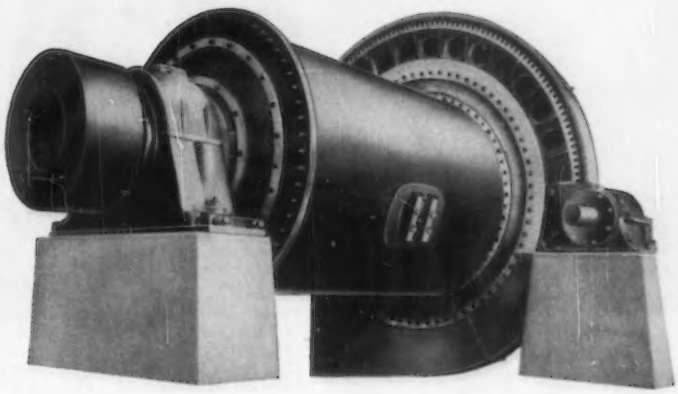


Traylor Ball Mills are made in two types—overflow and diaphragm discharge. They are built for either wet or dry grinding.

Traylor Ball Mills feature shell liners of manganese or high carbon steel in plain, wave, cascade, lifter or Lorain types with shells of welded steel construction. Trunions are cast integrally with the detachable heads. Main bearings are made of Meehanite* metal, larger sizes fitted with a high-pressure Alemite pump. Driving gears are steel, precision-cut on our Maag gear generator. Write for Bulletin No. 11-121 today!



Traylor Grinding Mills are available in Ball, Rod, Compartment and Tube Mills.

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George E. Gopher says:
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Ontario *(Continued)*

tory of its Gowganda area silver mine. Output for the first nine months, 1959, amounted to 1,102,132 oz, up from 941,794 oz for the corresponding period of 1958. Both exploration and development results at the mine continue to be satisfactory.

Violamac Mines has added a second machine to speed drilling at its Kam Kotia copper-zinc prospect, 14 miles west of Timmins. Current drilling is testing a new anomaly, which was outlined for length of approximately 1,400 ft. and width of from 175-200 ft. Initial drilling has returned values in copper but more drilling will have to be done before potential can be determined. There are also three other smaller anomalies to be tested.

QUEBEC

A $22-million steel plant that will employ up to 300 men and use iron ore from Hull is to be established on the south shore at Varennes, it was announced here over the weekend.

The plant owned by the newly-formed Quebec South Shore Steel Corp., will be the first integrated steel mill established in Quebec.

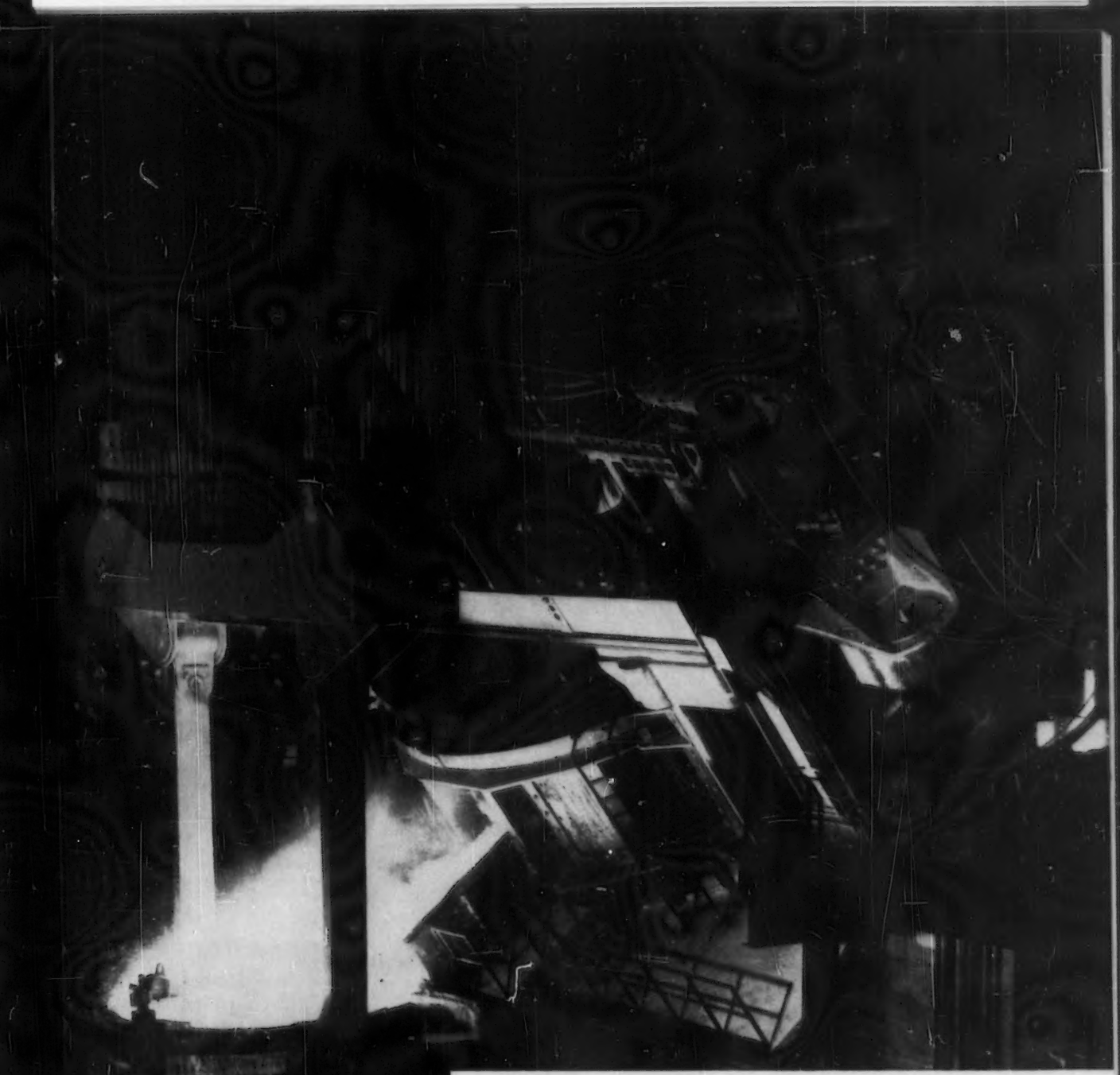
Starting in 1961, it will produce pig iron, semi-steel and steel products for Quebec and Ontario markets. Contracts launching the project were signed in Montreal by Quesco, Koppers of Canada Ltd., Koppers Co. Inc. of Pittsburgh and Strategic-Udy Metallurgical & Chemical Processes Ltd., of Niagara Falls, Ont.

Officials of the companies said the plant's steelmaking process is the first of its kind in North America. It utilizes two electric furnaces, capable of producing 150,000 tons of finished metal each year (E&MJ, June 1958, p 85).

Gold production at East Malartic Mines in the Malartic area is holding close to the all-time record established last year. In the first nine months, 1959, the mill handled 407,889 tons for total production of $2,733,378, an average recovery of $7.25 per ton. In the corresponding period, 1958, 407,862 tons was milled for output of $2,793,347, an average recovery of $7.33 per ton. Preparations are continuing for deepening the shaft below the 24 level with actual sinking scheduled to start early in 1960.

St. Lawrence River Mines is constructing a pilot plant in Montreal for treatment of columbium ores from its Oka area deposits. The plant will provide concentrates for further testing of refining methods and to investigate uses in high temperature alloys. Capacity of the plant will be around 4 tpd.

Mount Wright Iron Mines estimates that there is a total of 147-million long tons of beneficiating iron ore available by open pit from two deposits in the southern section of its Mount Wright area property. Average grade is placed at from about 29%-32% iron. Tonnage is based on results of diamond drilling to



New 200-ton Lectromelt furnace swings into service at Republic Steel

This new 24-foot, 200-ton top-charge-type Lectromelt electric furnace is powered for large-scale production . . . built for maximum availability, minimum downtime between heats.

For *your* new melting capacity contact Lectromelt. As the world's most experienced builder of electric furnaces we deliver *performance*. Lectromelt Furnace Division, McGraw-Edison Company, 322 32nd Street, Pittsburgh 30, Pennsylvania.

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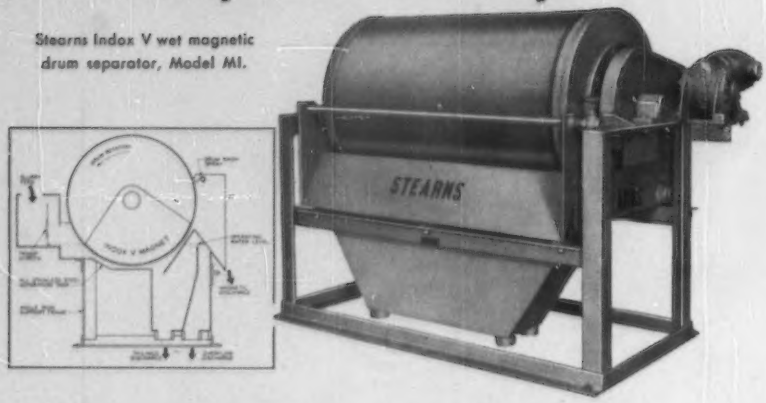
Stearns amazing new Indox V magnets boost heavy media recovery

Stearns Indox V wet magnetic drum separator, Model MI.



For cobbing or roughing iron-bearing ore

This new Stearns WPD heavy media separator is made with INDOX V — the amazing new ceramic material which obsoletes all other types of permanent magnets. INDOX V gives you a lighter-weight, lower-cost magnetic separator with a MORE EFFICIENT POLE STRUCTURE AND POWERFUL MAGNETIC FIELD. The results: increased efficiency, lower media recovery cost.

Indox V magnets cut costs

You get excellent mechanical performance with INDOX V permanent magnets. They assure a constant magnetic field with no power cost, no coils, no possibility of electrical failure within the magnet. Drum separator is an integral unit — no belt cost involved.

Big-capacity unit

The model MI, type WPD magnetic separator provides maximum media recovery at high-volume capacity. An important performance feature of the INDOX V WPD unit is its ability to discharge a magnetic concentrate of high specific gravity which, in coal preparation plants, permits plant operation without a densifier. The Stearns WPD incorporates a greater amount of tailing discharge area, and PRODUCES A CLEANER MAGNETIC CONCENTRATE than other wet drum separators. Stearns design provides for a minimum entrapment of non-magnetics in the magnetic concentrate.

Seven models — 30" dia. x 15" to 30" dia. x 72". Experience indicates a slurry feed of 8 gpm per inch of magnet width is a good figure for selection of separator size. See your Stearns representative for full details or write for Bulletin 2012D.

STEARNS MAGNETIC PRODUCTS

A DIVISION OF THE INDIANA STEEL PRODUCTS COMPANY

635 SOUTH 28TH STREET • MILWAUKEE 46, WISCONSIN

Quebec *(Continued)*

depth of 750 ft. In addition, limited work on what is known as the northern deposit has outlined a probable 7.2-million tons grading 27.86% iron.

Orchan Mines is extending the recently discovered zinc-copper deposit in diamond drilling at its property in the Mattagami area. The latest drilling has expanded the north-south width of the deposit to at least 200 ft and to depth of at least 1083 ft. Diamond drilling is being continued with two rigs.

New Hosco Mines is adding tonnage to the main copper deposit in diamond drilling on its Allard River, Mattagami area property. Initial estimates place tonnage in the main "A" structure at a minimum of 1.5-million tons grading better than 3% copper. That represents an increase of around half a million tons on the original estimates made last winter. Including the deeper "B" structure, which has still to be delimited, overall tonnage is calculated to be well over 2-million tons of better than 2.5% copper.

IN LATIN AMERICA

BOLIVIA

Through a supreme decree, the Bolivian Government fixed the tin export quotas for the last quarter of 1959 (Oct. 1 to Dec. 31), in a total of 6,517 short tons as follows:

	Short tons
Mining Corp. of Bolivia (Nationalized mining)	5,081
Mining Bank of Bolivia (Small mining)	802
Medium mining	634
Total	6,517

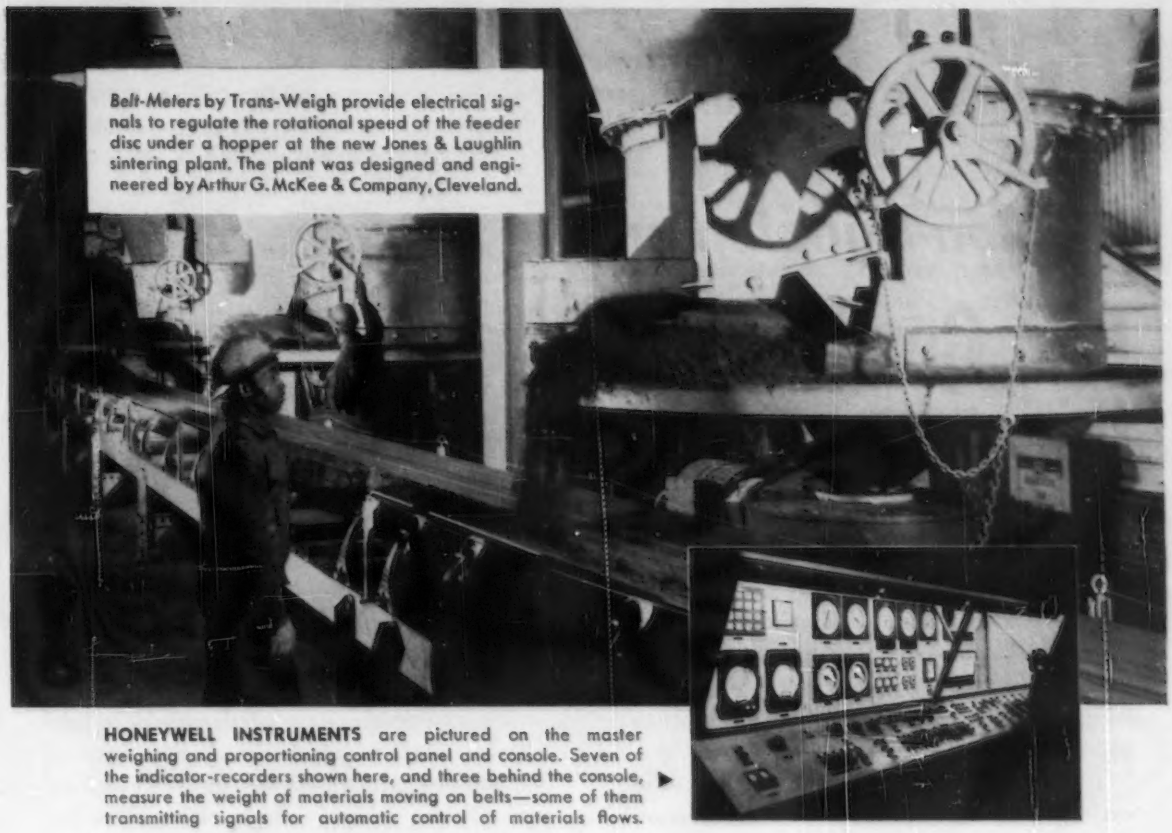
The total medium mining quota is distributed as follows:

	Short tons
International Mining Co.	142
Fabulosa Mines Consolidated	120
Tihua Mines	98
Empresa Minera Cerro Grande	131
Bolivian Tin Corp.	22
Empresa Minera Porco	12
Empresa Minera Totoral	17
Empresa Minera Ocurí	18
Empresa Minera Avicaya	49
Devon Corp.	13
Empresa Minera Cruz Roja	12
Total	634

With the attendance of Bolivia's president and several members of the executive branch in October, South American Placers officially started the big-scale exploitation of gold in the Teoponte area, located at the Pacajes province in the Department of La Paz.

An American company, SAP started working in Bolivia at the middle of 1956, under a contract signed with the government, and from now on will produce a monthly average of 220 lb of gold.

WHEN YOU MELT



Belt-Meters by Trans-Weigh provide electrical signals to regulate the rotational speed of the feeder disc under a hopper at the new Jones & Laughlin sintering plant. The plant was designed and engineered by Arthur G. McKee & Company, Cleveland.

HONEYWELL INSTRUMENTS are pictured on the master weighing and proportioning control panel and console. Seven of the indicator-recorders shown here, and three behind the console, measure the weight of materials moving on belts—some of them transmitting signals for automatic control of materials flows. ▶

Sinter mix automatically weighed and proportioned at Jones & Laughlin plant

Honeywell *instruments control continuous process*

There's no time out for weighing materials at Jones & Laughlin Steel Corporation's 2,500 ton-per-day sintering plant in Cleveland. An automatic system weighs iron ore fines, coke breeze and flue dust, and feeds them in exactly right amounts to the sintering machine. The *Belt-Meter*® system, supplied by Trans-Weigh Company, King of Prussia, Pa., features a continuous electrical weighing technique and uses Honeywell instruments to control and proportion flow rates of materials as they move along a short section of belt.

The system consists of three main parts: (1) an electric tachometer to measure belt speed, (2) an electric strain gage load cell to measure belt load, and (3) an *ElectroniK* potentiometer to indicate and record flow of materials in tons per hour. In addition, a magnetic amplifier controls flows from table feeders. Twelve automated weighing units check materials as they move through every important phase of the sintering process. Operators can vary ratios and switch to manual control when desired.

You'll find Honeywell instruments controlling virtually *every* type of process in the modern steel mill . . . improving productivity, keeping quality standards high, and bringing important day-to-day economies. Your nearby Honeywell field engineer can help you gain these advantages in your own plant. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*

Tuition Supplements—

One Good Way To Help Our Colleges And Universities

The business community has made an impressive start in going to the desperately needed financial aid of our colleges and universities. Business contributions to higher education have increased from only $40 million in 1950 to $136 million in 1958.

This rise in financial aid to higher education should be a great source of satisfaction to the business community. But it goes only part way toward meeting the growing needs of colleges and universities for financial help. Over the next ten years business aid to our privately supported colleges and universities alone must increase to at least $500 million a year merely to provide decent faculty salaries and meet the increased operating costs of taking care of enrollments that will almost double.

One pervasive reason why many business firms have not joined the ranks of the companies contributing to higher education seems to be that, in the interest of prestige and public relations, they are making their provision of aid contingent upon finding some particularly novel way of providing it. So long as this point of view persists, business aid will lag, for there are simply not enough ways of providing financial aid that are both notably novel and sensible.*

How The Plan Works

There are, however, some well-tested ways of providing aid which improve rather than fade in appeal with more using. One such way is the making of supplemental tuition payments to colleges and universities at which a company's employees take courses.

Many companies have scholarship or tuition-refund programs which cover all or part of the costs to their *employees* of taking college courses. But, in most colleges and universities, tuition charges fall far short of covering the full cost of the education given. By making an unrestricted "cost-of-education" grant a part of their employee scholarship or tuition-refund plans, these companies could make a material contribution toward covering the *college's* full costs as well.

The tuition supplement can be a fixed amount or a percentage of the tuition charged. Some plans provide for supplements as high as 100% of tuition, though there is usually an upper limit to the total supplemental payment given for each employee enrolled in the institution.

The plan seems to have originated with the Ford Motor Company Fund. When we at McGraw-Hill first learned of it, it appealed to us as having so many advantages, and so few disadvantages, that we adopted it as one part of our own program of financial aid.

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*The efforts of the McGraw-Hill Publishing Company to find a suitable method of aiding higher education prompted the writing of a "more or less Socratic dialog" entitled *A Business Wrestling with the Problem of Aid to Colleges and Universities*. Copies of this pamphlet, which underlines the difficulty of finding both a novel and satisfactory method of providing aid, are available on request.

HOW THE HEADS OF SOME OF THE INSTITUTIONS TO WHICH McGRAW-HILL HAS MADE GRANTS FEEL ABOUT THE TUITION SUPPLEMENT PLAN

"We are pleased not only because this addition to the never adequate supply of non-earmarked funds is a most welcome one, but also because it attests to the fact that the employees of our neighboring business firms are benefiting from the courses we offer at times convenient for them. We hope this mutually beneficial plan may continue and grow with the years."

Grayson Kirk, President
Columbia University

"I shall take this occasion to express deep sentiments of appreciation, in my own name and in the name of the members of the Board of Trustees, for the very effective manner in which your corporation is aiding higher education by the payments made under your tuition supplement plan. Certainly your action is indicative of the fact that you realize industry and higher education must join forces to preserve the basic American system of free enterprise."

Very Reverend John A. Flynn, C.M.
President, St. John's University

"The growing recognition by business and industry of the financial needs and important services rendered to the community by the colleges and universities is most encouraging, and Temple University is deeply appreciative of the fine support extended through McGraw-Hill's program of supplementary grants."

Robert L. Johnson, President
Temple University

The Plan's Advantages

The main advantages of the tuition supplement plan are:

- **It is simple and easily administered.** Payments can be made when scholarships or tuition refunds are granted, or at another time convenient to the company.
- **It relieves the company of the difficult and sometimes disagreeable task of choosing one college rather than another.** The individual employee makes the choice.
- **It directly serves the interest of the company by encouraging and aiding the institutions where its employees take courses.** In a sense, the company makes contributions in direct proportion to the value it receives in education for its employees.
- **It directly serves the interest of the colleges and universities receiving the grants by getting money to them in the form most appreciated**—unrestricted funds to be used at the discretion of their administrators.

Largely because tuition supplements are unrestricted as to use, this plan enjoys the unqualified approval and gratitude of the schools receiving such aid. This is not true of some of the other plans for granting aid to colleges and universities.

Tuition supplements, of course, can't be regarded as large efforts relative to the need of higher education and the responsibilities of business. But they are a very practical and useful first step, involving almost no problems. If you are not familiar with the idea of supplemental grants, why not discuss it with some of your friends in the field of higher education?

The Price Of Novelty

Our experience with tuition supplements indicates that this is an excellent plan, and we are glad to recommend it to other companies looking for an effective method of providing financial aid to higher education.

At any rate, we hope that business firms will not postpone granting financial aid until they find some novel way of doing it. If they do, it will be another case of too little and too late.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw
PRESIDENT
McGRAW-HILL PUBLISHING COMPANY, INC.

CHILE

Peñarroya has finished the geological work it was doing at the Malva deposit which is the most southern of four similar deposits it owns near Calera, halfway between Santiago and Valparaiso. Grade in the deposits is almost 3% copper.

Compañia Minera de Tocopilla which operates a 300 tpd flotation mill near the nitrate port of Tocopilla will build a leaching plant to treat its oxide ores. Consumption of acid will be about 7 tpd which the company will obtain from CORFO's 35 tpd plant which has been operating at the port of Antofagasta for three years. At the plant, Chilean sulphur, 99.5% fine, is obtained from volcanic deposits in the Cordillera. Cost of sulphur at the port of Antofagasta is reported to be $35 per metric ton against $22 to $23 for Frasch sulphur, fob mines, Mexico.

MEXICO

Noranda of Canada, via its Mexican subsidiary, is reported setting up a mercury plant in San Luis Potosi.

Dowa de Mexico, a subsidiary of Japanese Dowa, is working over an old mercury mine in Guerrero State at Huitzuco. The Japanese feel the mine has many more possibilities than were worked during its many years in the past.

A $4-million aluminum plant is planned for Vera Cruz on the Gulf Coast. Bauxite will be imported from Chile and Paraguay, according to a report from the City of Vera Cruz. That would fit in with the big Papaloapan hydro-electric dam just being finished (some 150,000 kw) nearby. Also, for future aluminum and metals production, a $32-million hydro-electric dam is being planned for the Grijalva River system in Chiapas State—450,000 kw. Eventually it is hoped that the area will have enough extra power for mineral reduction and other industrial needs.

Mexico's Secretary of Public Health was asked to investigate atmospheric contamination by sulphur dust and sulphur dioxide in the Gulf port town of Coatzacoalcos on the Isthmus of Tehuantepec.

The world's largest plant for the direct reduction of iron ore to sponge iron is shown taking shape in Monterrey. The plant will use the new HyL process to reduce iron ore by direct contact with hot, reformed natural gas in batch-type reactors to produce 500 tpd of sponge iron. It was designed and is being built in Monterrey by the M. W. Kellogg Co., New York, for Fierro Esponja, an affiliate of Hojalata y Lamina, one of Mexico's leading steel producers.

The new plant is scheduled for production in early 1960. It will be the second HyL plant built. The first, a 200 tpd plant, is located adjacent to the new plant site and is owned and operated by Fierro Esponja and has been in operation since 1958.

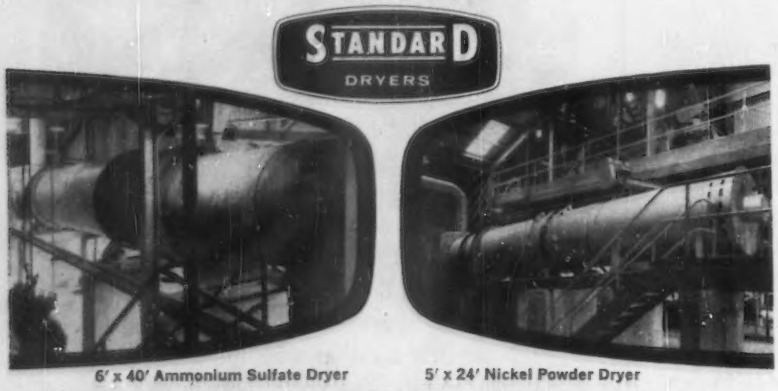
HAITI

Denver Equipment Co. is building a 1500 tpd copper flotation plant for Sedren S.A. at their Meme mine in the Meme Valley. The original contract was awarded to Denver Equipment Co. Ltd., (London) by Consolidated Halliwell Ltd. and Consolidated Mogul Mines Ltd. of Toronto and the target date for start-up is May 1960. The ore to be processed is a high grade mixture of bornite and chalcopyrite and test work indicates that recovery and grade of concentrates will be high, it was reported.

AUSTRALIA

Australian production of aluminum has reached the capacity level of 13,000 tpy and bauxite supplies are reaching Australia from India and Malaya in addition to the previous sole supplier, Indonesia. It is understood that bauxite from other areas will be examined for eventual import into Australia.

National Minerals Holdings Ltd. plans to increase production of rutile by 50%.



6' x 40' Ammonium Sulfate Dryer

5' x 24' Nickel Powder Dryer

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Freeport is destined to be the capitol of U.S. nickel and cobalt production and a leading source for ammonium sulfate.

NICKEL POWDER is processed in a parallel flow STANDARD rotary dryer at a feed rate of nearly 10 tons/hour wet basis.

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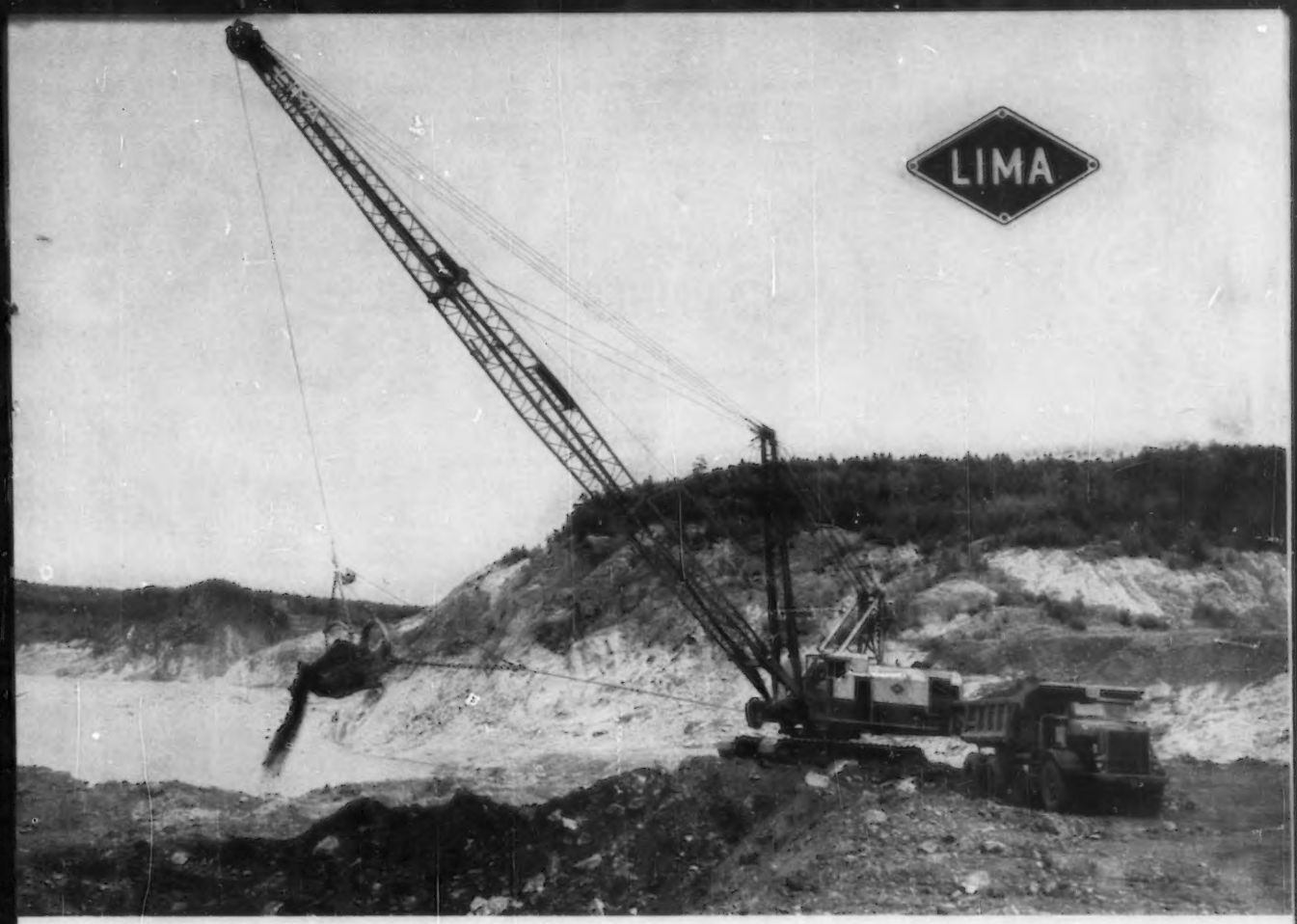

Lima Type 2400 dragline speeds iron ore stripping operations.

Limas dig, strip or load more . . . for less cost!

It takes a rugged breed of men and machines to mine the ores deposited so willfully around the globe by nature. Limas are part of that special breed. For wherever mining jobs call for more digging, stripping and loading capacity . . . at less cost . . . you will find Limas doing more than their share of the work.

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The Lima Type 2400 is muscled for the really big mining jobs—as a variable capacity dragline, 6-cu. yd. shovel, or 110-ton crane. It is mounted on wide and long crawlers for extra ground contact and easy handling. Large-diameter drums are extra wide for increased cable capacity.

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There is a Lima type and size for every mining operation! Shovels ½ to 6 cu. yds., variable capacity draglines, cranes to 110 tons. Get full information today from your nearest Lima distributor on powered-for-profit Limas—or write to us.

Lima shovel team speeds Mesabi Range ore loading—Type 604, left, 1½ cu. yd., and Type 1201, 3 cu. yd.

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Australia (*Continued*)

It will shortly place in production the largest single wet-plant unit in Australia which will be situated at the huge Redhead deposit. Increased output would mean a considerable drop in production costs.

Gold and copper output rose last fiscal year at Mt. Morgan Ltd.'s mine. Gold output went up from 51,826 to 68,714 oz and copper from 7,579 to 8,258 tons even though ore milled was 93,000 tons lower at 728,050 tons. Ore reserves are now 11.9-million tons.

Mt. Lyell Mining Co. Ltd. is already implementing its decision to increase production of copper concentrate. In the first three months of the current fiscal year, output of copper concentrates rose from 2,735 to 3,186 tons. Production target is a minimum of 11,000 tons a year.

IN THE PHILIPPINES

In the first six months of 1959, the Toledo copper mine of Atlas Consolidated Mining & Development Co. shipped 40,291 tons of copper concentrates to Japan, containing over 21-million lb of copper. That was a 14% increase over the same period of 1958. Operations were hampered by shortage of equipment and spare parts. In particular, waste stripping was affected which prevented attaining the production for which the mill was geared. Import of equipment is dependent on dollar allocations granted by the Central Bank and because of the foreign exchange position of the country, there have been restrictions on dollar purchases.

At the Mati mine in Davao, controlled by the same company, production and sales of raw ore and iron concentrates for the six months amounted to 36,526 tons of lump ore and 58,100 tons of concentrates with a total value of $950,000.

September production of the Toledo mine amounted to 3.75-million lb of copper from milling 336,000 tons of 0.62% copper ore.

Exploratory drilling on areas adjacent to the company's holdings have been successful in disclosing an indicated large tonnage of 0.7% copper ore. The drilling program will be continued into 1960.

Lepanto Consolidated continues its regular shipments of copper concentrates to the Tacoma smelter. Latest was 10,250 tons, estimated to contain 5,785,000 lb of copper and 8,900 oz of gold.

Benguet Consolidated, largest gold producer in the Philippines, is milling about 3,300 tpd of 0.2 oz gold per ton. Because of the high price of gold in the Manila open market, the company realizes about twice the statutory price for its bullion and is making a satisfactory profit. Ore reserves are sufficient for at least three years. The company is conducting a vigorous prospecting campaign for copper in the Southern Islands.

In the first half of this year, Benguet's operating profit from its gold mining operations reached an all-time high of $2-million compared to $1.3-million in the same period of 1958. Indications are that the second six months will show even better results. Income from a chrome contract increased 20% over 1958. A total of 255,000 tons of refractory grade chromite were shipped during the six-month period. It is estimated that 600,000 tons total will be shipped in 1959.

IN AFRICA

The Swaziland Iron Ore Development Co. (a subsidiary of Anglo American) is continuing drilling operations on the Bomvu Ridge in Swaziland. An exploratory adit into the thickest section of the iron orebody has been commenced and is reported to be progressing well.

All the mining houses are prospecting vigorously in the Transvaal or the Orange Free State for fresh gold deposits. It is reliably estimated that upwards of 5-million acres in the two provinces are now held under option by the mining-finance houses and independent concerns.

CHECK THE NEW

Connellsville

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The Service Elevator for Preparation Plants and Underground Installations

- REDUCE DOWN TIME
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This all-steel Connellsville MINICAGE with 1000 lbs. and up capacity travels the outside wall of an existing preparation plant . . . or may be designed for inside a future-planned facility. Operates automatically at speeds of 50 to 75 feet a minute.

The sturdy fabricated steel structure with pantograph-style gate is mounted in place and safely attached to wall. Drive assembly at top of structure is coordinated with the MINICAGE and level doors by a control system. Wall openings at levels have hinged safety doors.

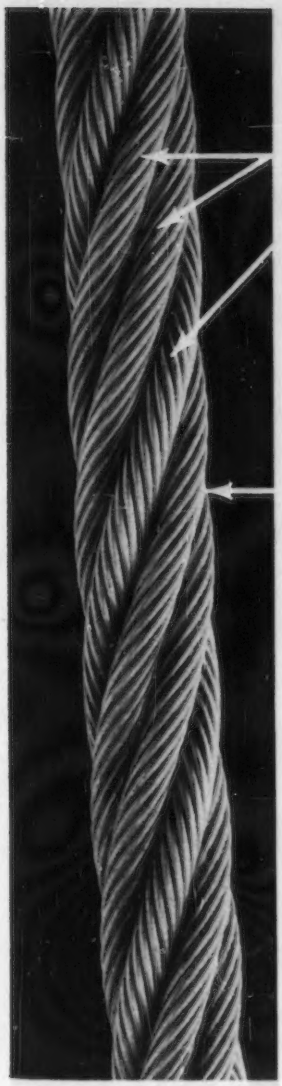
The entire Connellsville MINICAGE installation complies with federal and state mining laws.

For additional information and details on the Connellsville MINICAGE and other elevators, cages, hoists and conversion units, write for Bulletin No. 200.

Raising Production SINCE 1901

Connellsville MANUFACTURING

CONNELLSVILLE, PENNSYLVANIA



Herringbone's two pairs of Lang lay strands and one pair of regular lay strands provide the ideal combination of maximum flexibility with good stability.

Finer wires inside contribute to Herringbone's excellent drum-winding characteristics.

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*Reg. App. For

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ROEBLING
HERRINGBONE
WIRE ROPE

Africa *(Continued)*

There is no way of estimating the value of gold in the undeveloped areas. But any one territory might contain reserves equal to those of the new Free State goldfields where mining is taking place. The Government Mining Engineer estimates that the towns of the Free State goldfields are situated on top of gold valued at no less than £4,344,000,000 ($12,135,000,000) based on the present gold price. The 11 mines concerned contain something like 700-million tons of gold ore from which there is 350-million fine oz to be extracted.

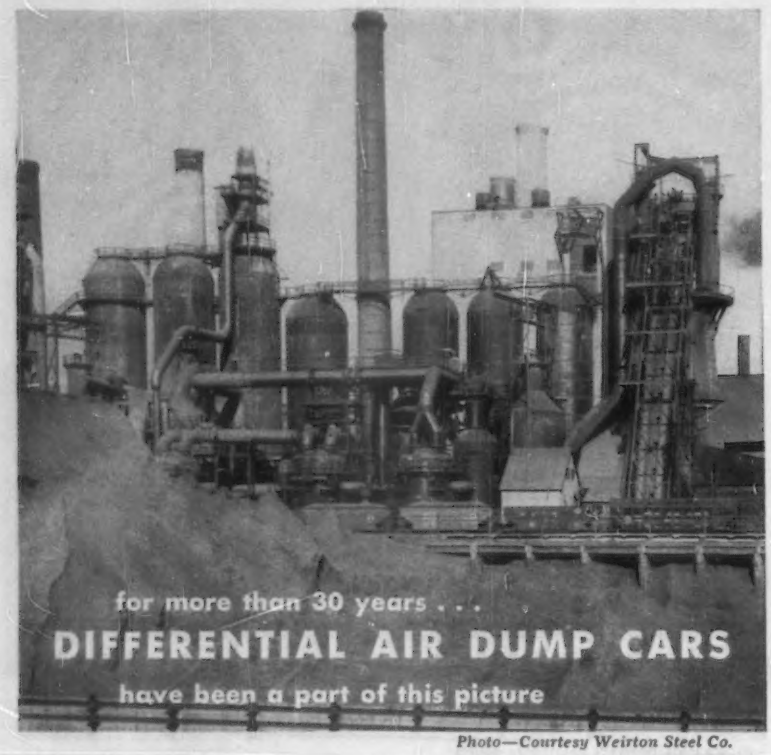
Blyvooruitzicht, one of the Central Mining group of mines, on the West Witwatersrand has purchased more ground on its northern boundary in the area where the new circular shaft No. 4 will be sunk. It has been decided to make the shaft larger than originally planned. With a 26-ft dia. instead of the 24 ft. originally budgeted for, it will be possible to employ two large automatic hoists to the best advantage and to accommodate them in one building instead of two. The change of plan is not expected to raise the over-all cost of the shaft, however. Cost is expected to be about £2,720,000 ($7,616,000).

An entirely new gold-mining area may eventually be opened up in South Africa as a result of activity by a company—Republic Gold Mining Co.—in the Humansdorp district of the Eastern Cape Province, just over 50 miles from Port Elizabeth.

Plans for increasing the milling rate of the West Driefontein gold mine—on the West Witwatersrand—to 205,000 tpm have been announced by the Consolidated Gold Fields group. Capital cost of the expansion over the next five years will be £9-million ($25.2-million). An optimistic view of the mine's prospects flow from the encouraging results of exploration on the Ventersdorp contract reef as well as from boreholes sunk to get information about the eastern zone of the property.

A record tonnage of electrolytic copper has been produced this year by copper refineries in Northern Rhodesia. Provisional production figures for the first nine months of 1959 are 271,608 tons of electrolytic copper valued at $171,935,442. The highest previous total was 246,680 tons produced during the first nine months of 1957.

The provisional value of $27,428,212 for all minerals mined in Northern Rhodesia during September brings the aggregate for 1959 to $255,753,110.



Photo—Courtesy Weirton Steel Co.

Growing with the mighty steel industry, answering the need for Gibraltar tough dump cars that can stand the punishment which only a steel mill can hand out, Differential cars have made many fast friends among steel's "men who know".

A substantial growth in sales — including many repeat orders — reflects a recognition of the quality and performance built into Differentials.

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SINCE 1915 PIONEERS IN HAULAGE EQUIPMENT

IN EUROPE

GERMANY

Farbenfabriken Bayer A.G., Leverkusen, has constructed a plant to recover large amounts of ferrous sulphate originating from its titanium dioxide plants. The plant not only stops water pollution by iron wastes but is suited, with its 180,000 tpy capacity to produce 58,000 tpy of sulfuric acid (96%) plus 52,000 tpy ferric oxide with 63% iron content.

RUSSIA

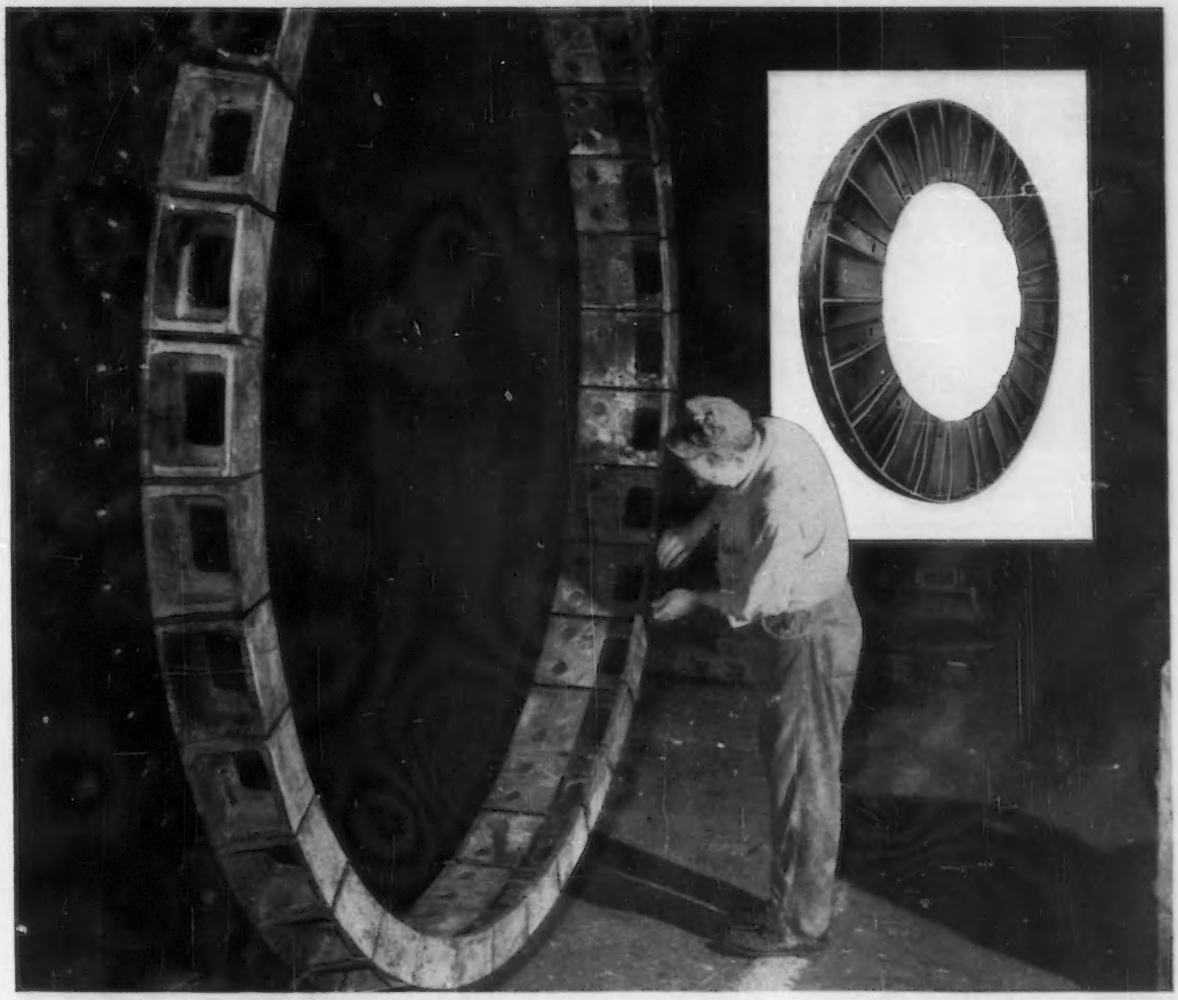
Conveyor belts of 2,000 mm (78.7 in.) width were delivered to Kriwoj Rog iron plant by the British BTR Industries Ltd. TASS reports. Belts of 1600 mm (67.9 in.) width were delivered by an East German state enterprise. All other components of the Kriwoj Rog ore processing center were delivered by Soviet enterprises.

The Kriwoj Rog station, claimed to be Europe's largest with an annual output capacity of 4.5-million metric tons of concentrates, is the first of five such processing centers scheduled to go on-stream during the current (1959 to 1965) Seven-Year Plan.

TASS claims that it is the USSR's most modern plant, having all components mechanized and automated. Ore charging to the bunkers is effected with the aid of radioactive isotopes. One dispatcher station governs the entire center's activities.

The open-pit mining sites are worked with machines of 8 cubic meters (282.5 cubic ft.) bucket capacity.

Multi-roller magnetic separators pro-



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Longer brick life and longer continuous service are being attained by 275 kilns in 54 plants using B&W Nose and Tail-Ring Castings. In many cases, the life of these castings has exceeded 9 years.

Light and strong B&W Alloy Castings have improved kiln performance in most installations. Made of heat-resisting Grade HH alloy, nose ring castings eliminate belling out of the kiln shell, assuring longer brick life and longer continuous operation of the kiln. By protecting the end of the kiln shell from direct flame, the nose ring castings prevent "feathering-down" of the shell because of oxidation. Their design eliminates cracking and warping, experienced with large size castings.

Small size and light weight make B&W Castings easy and inexpensive to install. The protecting flange on the nose ring castings permits the use of low-alloy steel bolts for fastening.

Spare part inventory may be kept low because the same nose ring castings may be used on kilns varying up to 4 feet in diameter, depending upon size. Write for Bulletin S-17. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

S-467

"SO WE LUBRICATE IT WITH LUBRIPLATE"

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Russia (*Continued*)

duce concentrates ranging from 62% to 64%. Fe-content out of ores possessing a 32% Fe content level. This is a major improvement over the older Kriwoj Rog processing centers which yielded concentrates of maximally 59% Fe content.

One of the Soviet Union's largest aluminum works is under construction in North-East Kazakhstan SSR in an area where, near the factory, the town of Arkalyk is now built up for construction workers. TASS reported that Victor Ponomarjow, corresponding member, Kazakh Academy of Sciences, revealed plans concerning the project.

Ponomarjow is tied with the project since the factory will employ a new method of bauxite processing aimed at "eliminating the complicated technological process of sintering alum earth." The new process is based on the large deposits of bauxite possessing high contents of silica, found in that factory's neighborhood.

The USSR plans to gain 94-million metric tons of iron ore from its mines this year, TASS reports. That output will bring the country to the leading spot in the world, amounting to 79% of the U.S. all-time high output of 1953.

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Spans the valleys, make molehills of mountains! Riblet aerial tramways cut costs, save time.

For over 60 years Riblet has met and defeated transportation obstacles both climatic and topographic. Unique are the features in the custom designed aerial tramways, making them highly efficient on the level as well as in unaccessible areas. Write for a complete, illustrated brochure.

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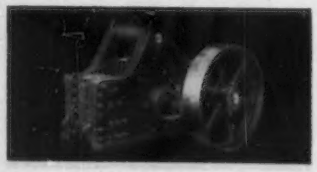
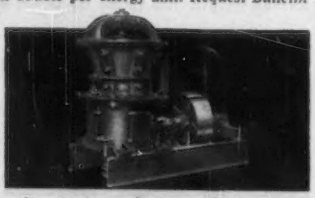
Sturtevant Construction Assures Long Mill Life at Top Loads

Sturtevant crushing and grinding machinery answers the long life top-load production problem for medium to small size plants. Many Sturtevants have been operating above rated capacities for more than 25 years, and *without a major repair.*

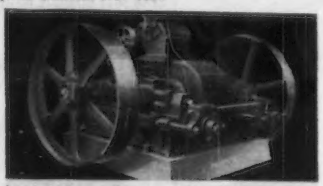
"Open-Door" design gives instant accessibility where needed — makes cleanouts, inspection and maintenance fast and easy. Machines may be set up in units to operate at equal quality and capacity.



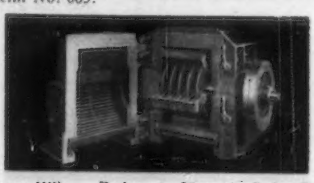
Jaw Crushers — Produce coarse (5 in. largest model) to fine (⅛ in. smallest model). Eight models range from 2 x 6 in. jaw opening (lab model) to 12 x 26 in. Capacities to 30 tph. All except two smallest sizes operate on double cam principle — crush double per energy unit. *Request Bulletin No. 062.*



Rotary Fine Crusher — Reduce soft to medium hard 3 to 8 in. material down to ¼ to 1¼ in. sizes. Capacities up to 30 tph. Smallest model has 6 x 18 in. hopper opening; largest, 10 x 30 in. Non-clogging operation. Single handwheel regulates size. *Request Bulletin No. 063.*



Crushing Rolls — Reduce soft to hard 2 in. and smaller materials to from 12 to 20 mesh with minimum fines. Eight sizes, with rolls from 8 x 5 in. to 38 x 20 in.; rates to 87 tph. Three types — Balanced Rolls; Plain Balanced Rolls; Laboratory Rolls — all may be adjusted in operation. *Request Bulletin No. 065.*



Hammer Mills — Reduce to 20 mesh. Swing-Sledge Mills crush or shred medium hard material up to 70 tph. Hinged-Hammer Pulverizers crush or shred softer material at rates up to 30 tph. Four Swing-Sledge Mills with feed openings from 6 x 5 in. to 20 x 30½ in. Four Hinged-Hammer Pulverizers with feed openings from 12 x 12 in. to 12½ x 24 in. *Request Bulletin No. 084.*

**Reports Manager W. Carleton Merrill concerning Sturtevant Swing-Sledge Mill at James F. Morse Co., Boston.*

STURTEVANT MILL COMPANY
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Now you can get HIGH recovery – capacity concentration from high silica iron ores at LOW cost with DINGS CORONATRON

High Intensity ELECTROSTATIC SEPARATORS

Here is the solution to the problem of economical concentration of dry, granular iron ores. Dings' research and extensive testing of many recently discovered quartz-hematite iron ore deposits have determined that the high intensity, low voltage electrostatic separation obtained with the Dings Coronatron is the best and lowest cost concentration method for these and many other ores.

HERE'S WHY...

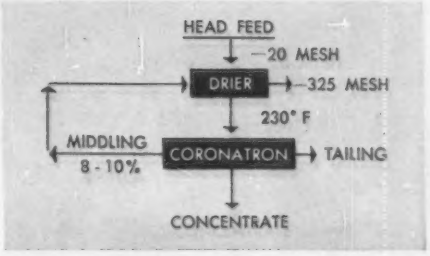
Tests have proved that in a single pass the Dings Coronatron delivers capacities up to three times higher than is possible with multiple pass, low capacity separators.

Recovery of iron is high. Greater dispersion of material in the Dings Coronatron permits concentration of an excellent grade of iron ore.

Such high recovery and high capacities with the Coronatron are made economically practical by the high intensity sparkless electrode, an exclusive Coronatron feature. The uniform field coverage generated with this electrode is accomplished at much lower voltages than is possible with conventional electrodes.

The flowsheet and table of results at the right show why more and more operations involving dry concentration are turning to electrostatic separation with the Dings Coronatron.

Where electrostatic separation is not practical, be sure to investigate all the advantages of Dings new Induced Roll Magnetic Separator. This improved-design unit permits highest capacities of weakly magnetic materials and assures extremely critical separation for production of high quality products.



Although early test work indicated that best results came from multiple-pass, low capacity separators, it was found more economical and practical to utilize the high capacity, single-pass Coronatron, using the flowsheet above.

IRON				
PRODUCTS	%	UNITS	DISTR.	% WT.
Head Feed	37.4	37.4000	100.00	100.0
Concentrate	68.5	35.6759	95.39	52.1
Tailings	3.6	1.7244	4.61	47.9
TOTAL	37.4	37.4003	100.00	100.0
Recovery of iron equals 95.39%				

Results on a typical Canadian quartz-hematite ore. Selection of the appropriate size and type of Coronatron depends upon test results on a given ore.

Dings Coronatron successfully used on

bituminous coal	ilmenite
chromite	monazite
dolomite	phosphate
feldspar	rutile
fluorspar	scheelite
garnet	silica
hematite	zircon

ES-259

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Russia *(Continued)*

proved to be too low grade.

Expansion has been ordered for the iron ore business in the Soviet Union; new capacities are to be opened annually. For 1959, the new capacity will amount to 26-million metric tons iron ore per annum. The expansion of the iron ore output is best shown by stating that the Kriwoj Rog area will, in 1965, produce more iron ore than the entire Soviet Union produced in 1958.

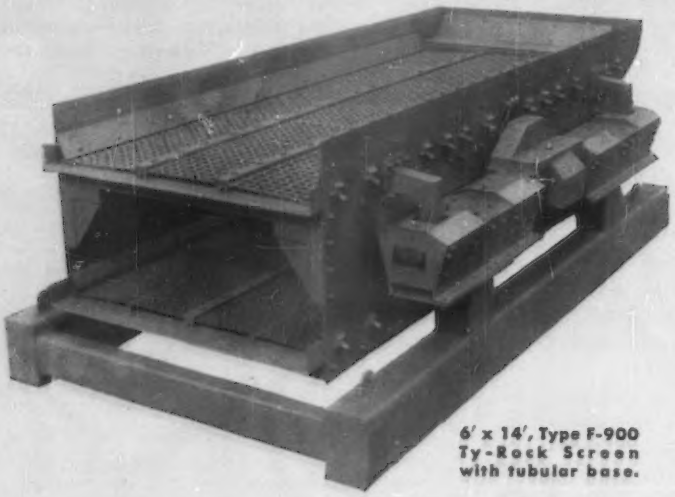
The discovery of 16- to 17,000-million metric tons of high quality iron ore in the Kursk Magnetic anomaly exceeds 100 times those of Kriwoj Rog deposits, opening vast new perspectives, TASS states.

IN MALAYA

At the end of September, Malaya had 35 dredges, 356 gravel pump mines and 42 other mines, for a total of 433 active tin mines. There were 21,731 persons directly employed in tin mining, compared with 21,667 at the end of August according to official reports.

The Federation and the U.S. are to conclude a tax agreement to encourage American investment in the Federation, according to the Honorable Tan Siew Sin, minister of finance. Following financial talks in Washington, Mr. Tan said experts from the two countries would begin talks.

TY-ROCK SCREENS



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PERSONALS

(Continued from p 126)

Thomas G. Ferguson has been elected president and chief executive officer of National Potash Co., according to an announcement by **Richard C. Wells,** former president, who was elected chairman of the board.

Ferguson

Mr. Ferguson joined National Potash as vice president and general manager when the company was formed in 1955. He has been in charge of the development and operation of the company's mine and refinery east of Carlsbad, N.M. Ferguson was vice president of the Pittsburg Coal Co. Div. of Consolidated Coal Co. before coming to National.

Charles W. Schwab, chairman of the national emergency lead-zinc committee for the past three years, has been named general manager of Kellogg operations of Bunker Hill, effective January 1, to succeed **Wallace G. Woolf,** who is retiring. **Miles P. Romney**, manager of the Utah Mining association, will succeed Schwab as chairman of the lead-zinc committee.

Richard Maclin Stewart has been appointed director of mining research of the Anaconda Co., according to **Richard S. Newlin,** vice president in charge of operations. Mr. Stewart who has been assistant director, succeeds **Edward R. Borcherdt,** who retired after 39 years service with Anaconda. (see E&MJ, Nov. 1959, p 182)

Stewart

Mr. Stewart came to Butte in 1948 as a miner, completed Anaconda's supervisor's training program in 1950, and was assigned to the mining research department. He became assistant to the mining research director in 1955 and was made assistant research director last February.

William B. Hall has been named president of Vitro Chemical Co., a newly formed subsidiary of Vitro Corp. of America.

The new company consolidates the chemical and metallurgical operations including those conducted by Vitro Uranium Co., Heavy Minerals Co., and Vitro Rare Metals Co.

Mr. Hall joined Vitro in 1951, and, from 1955 to 1958, served as president of Vitro Uranium Co., Salt Lake City. He was appointed vice president of Vitro Corp. of America in January 1959.

Charles B. Hausen, assistant smelter superintendent of the Bunker Hill Co., has been named to a newly created company position of corrosion engineer.

Personals *(Continued)*

Ira K. Hearn, Salt Lake City, has resigned as assistant general manager of Utah Copper Div., Kennecott Copper Corp., to accept the post of vice president in charge of operations, Celotex Corp., Chicago. His successor at Utah Copper has not yet been named.

Three vice presidents have been named for Vitro Chemical Co., a newly formed subsidiary of Vitro Corp. of America, according to **J. Carlton Ward, Jr.,** president of the parent firm.

Richard C. Cole, former president of Vitro Uranium Co., Salt Lake City, was named vice president in charge of manufacturing; **Paul R. Kruesi,** former general manager of the Rare Earths Div. of Heavy Minerals Co., Chattanooga, was named vice president, research and development; and **Malcolm H. McAllister** will become vice president of Vitro Chemical and, in addition, will continue as president of Berkshire Chemicals, Inc., a Vitro sales subsidiary.

Donald W. Lindgren and **Ernest K. Lehmann** have joined forces to do consulting work in mining geology under the partnership name of Lindgren & Lehmann.

Mr Lindgren was formerly chief mining geologist for the Northern Pacific Railway and Mr. Lehmann formerly did mining geology consulting on his own. Their new office is at 1355 N. St. Albans Road, St. Paul 17, Minn.

Stewart

Coe

John A. Coe, board chairman of American Brass Co., Anaconda subsidiary, will become a vice president of the parent firm, according to **Clyde E. Weed,** Anaconda chairman. Mr. Weed also announced that **Richard M. Stewart,** president of American Brass, would become its chief executive officer.

Mr. Coe has been associated with American Brass since 1920. In 1941, he was elected vice president in charge of sales. He then became executive vice president and, from 1950 to 1958, was president of the firm. Coe is also a director of several other Anaconda subsidiaries.

Mr. Stewart has been with the Anaconda organization since 1935 when he joined the patent department of Anaconda Wire & Cable Co., Hastings-on-Hudson. In 1939 he was appointed AW&CC's counsel. He joined the parent company in 1949 and in 1956 was named director of industrial relations.

Richard B. Steinmetz is the new president of Anaconda Wire & Cable Co., a 70%-owned subsidiary of the Anaconda Co. Mr. Steinmetz, who has been associated with the Anaconda organization since 1929, and who has been executive vice president since 1957, succeeds **William E. Sprackling** who is now retiring.

Vasily S. Emelyanov, chief of Russia's central administration for the use of atomic energy, last month visited Hidden Splendor Mining Co.'s uranium mine at Grants, N.M.

Fourteen other Soviet experts and several high-ranking members of the U.S. Atomic Energy Commission accompanied Emelyanov on his tour of the Hidden Splendor operation.

M. D. Ayers has been named director of engineering, Kennecott Copper Corp., according to **Charles R. Cox,** president.

Before Ayers came to Kennecott in 1956 as assistant to the president, he was chief engineer of the Wheeling Steel Corp.

From 1933 to 1946, Mr. Ayers served with the U.S. Steel Corp and then became chief engineer of the Hamilton Works of the Steel Co. of Canada.

Lawrence S. Pricher was elected a vice president of the New Jersey Zinc Co. He formerly was vice president (finance) of the Foster-Wheeler Corp.

Wing G. Agnew, head of the Bureau of Mines office of mining research at Spokane, has been named to the new position of mining engineer in the office of **Fred A. Seaton,** Secretary of Interior

duVerre

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Turn-Clean
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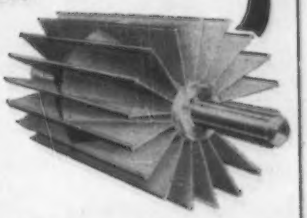

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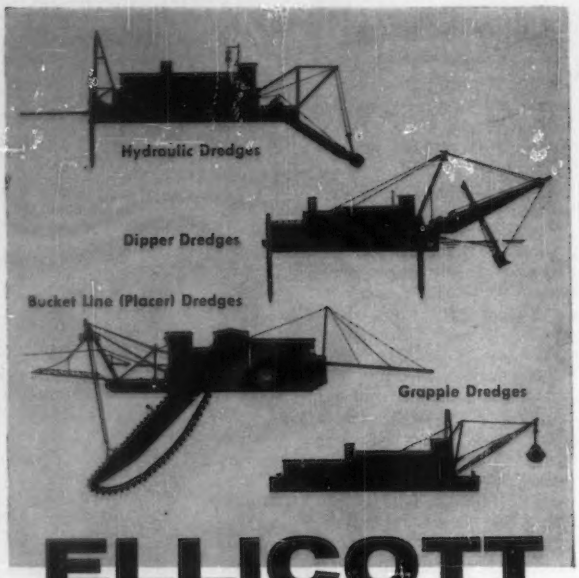

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Successors to the floating dredge business of the Bucyrus-Erie Co. and the American Steel Dredge Co. Complete engineering sales and repair parts service.

OBITUARIES

Louis S. Cates, 77, chairman of the Phelps Dodge Corp., died Oct. 29 at St. Luke's Hospital, New York.

Cates

Mr. Cates was born in Boston and graduated from MIT with a mining engineering degree in 1902. He then became timekeeper for Boston Consolidated Mining Co.'s operations at Bingham, Utah.

After serving the company in a number of varied assignments (foreman, mine-shaft boss, superintendent of mines), Mr. Cates became its general manager in 1910. The same year, Boston Consolidated was absorbed by the Utah Copper Co., and Mr. Cates became general engineer of the mines. He was then sent to Arizona to reorganize the operating staff of the Ray Consolidated Mine.

In 1913, Mr. Cates became Ray's general manager and, six years later, returned to Bingham as general manager of Utah Copper. While Cates was top man at Bingham, the open pit operations were electrified and the concentration plants remodeled to give a daily capacity of 75,000 tons of ore (at that time making it one of the world's largest ore producers).

Mr. Cates' prestige in the industry seemed to increase as steadily as the copper ore output until, in 1930, he became president of the Phelps Dodge Corp. He held that post until 1947 when he was elected the corporation's board chairman.

For nearly thirty years, Mr. Cates played a leading role in developing Phelps Dodge into one of the world's major producers of copper and copper products. One of the firm's biggest transactions, which Mr. Cates directed, was opening up and developing the $40-million Morenci pit in Arizona.

In 1938, Mr. Cates, who had already received many domestic and foreign awards (and who was to receive many more as the years went on), was elected William L. Saunders Gold Medalist of the AIME.

Julian Nardi, 62, chief mechanical engineer of Ford, Bacon & Davis, Inc., New York engineering and management consultants, was among the 26 persons who died in a Piedmont Airlines crash Oct. 30 in Virginia.

Nardi

Mr. Nardi began his career as a draftsman with Sargent & Lundy, Inc., Chicago, and in 1922 moved to Stone & Webster, Inc., Boston, where he became senior mechanical engineer.

From 1931 to 1932, he was engineer in charge at Stuart, James & Cooke, Inc., New York, and after a number of as-

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Obituaries *(Continued)*

signments in private practice as a consulting engineer, he joined Ford, Bacon & Davis in 1950.

Alexander Terpigorev, 86, leading soviet mining engineer and author of more than 250 scientific works, died recently in Moscow.

Perry G. Harrison, 74, a director of the Hanna Mining Co., died recently at Cleveland. He was associated with several iron ore and gold mining companies in this country and Mexico and was president of Evergreen Mining Co. when it was purchased by the M.A. Hanna Co. in 1946.

Reginald C. Dempster, 68, retired mining engineer, died Oct. 24 in Portland. He was a graduate of McGill University, Montreal, and a member of the AIME.

Kenneth E. Hamblen, Portland consulting mining engineer, died Oct. 13. He had helped to develop several Oregon mining projects, including the Oriole gold mine in Josephine County, the Blue Ridge quicksilver mine in Crook County and the Oregon King silver mine in Jefferson County.

Charles Kestle, 76, retired construction superintendent for the Anaconda Co., died Oct. 30 in Butte. He was a native of Cornwall, England, had lived in Butte since 1915, and was construction superintendent for Anaconda for forty years.

Albert W. Hahn, 76, noted metallurgical engineer, died recently in San Francisco.

Hahn graduated from Columbia University in 1905 and, five years later, founded the Metals Disintegrating Co., Elizabeth, N.J. The company pioneered in the production and uses of metallic powders.

Mr. Hahn arrived at San Francisco in 1936, and shortly thereafter founded the Metalead Products Corp., Palo Alto. He served as the firm's president until his retirement a few years ago.

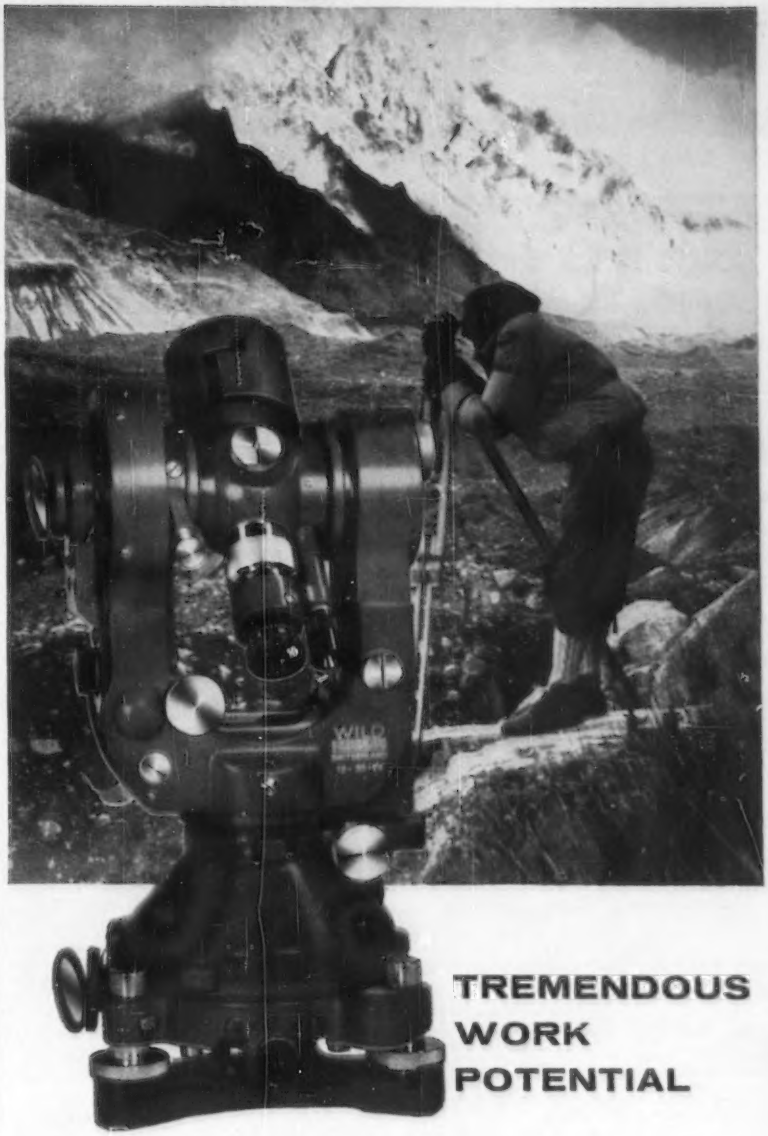
CORRECTION

I would like to call your attention to two items that appeared in the October '59 issue. (Andacollo, under Chile, p200; and Andacollo, under Peru, p202).

Inadvertently, and possibly misled by the source of the common announcements, a slight error has occurred. The Cerro Landa property, mentioned under Peru and by implication also under Chile, does not have any connection with Andacollo.

Andacollo has only been in existence in its present corporate form for about a year. Cerro Landa, on the other hand, represents work which has taken place over a number of years under the guidance of the undersigned, whose present interest in Cerro Landa is jointly with an American group NOT connected with Andacollo.

Very sincerely yours,
Howard Steven Stroth
Andacollo Mining Co. Ltd.



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Manager-Superintendent-Chief Engineer. Mining Engineer, 39, 18 years varied mining experience, last six in top management. Energetic, good organizer in establishing new mining operations, strong in personnel, labor and community relations, financial and cost accounting. 12 years in Latin America. PW-3045, Engineering & Mining Journal.

Mining Engineer, 20 years' experience under-ground mining from Mucker to Mine Superintendent, 7 years large open pit Shift Boss to General Pit Foreman. Prefer West or Southwest location. PW-3128, Engineering & Mining Journal.

Graduate Canadian Mining Engineer with ten years experience in exploration, development, production and plant engineering desires responsible position in engineering or production. Available December 1, PW-3129, Engineering & Mining Journal.

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For Sale-3-almost new intellin—giants extra nozzles $500 each. 2-universal drive shafts for heavy duty engines. Large placer deposit with water S.B. Mountains—near Yucca Valley—will join operation. 40-acre mining claim on highway near town. Write D. V. Cole P. O. Box 6 Johannesburg, Calif.

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For Sale, Exl terms, Lease, want partner, open pits. Y. J. Mine, Cobalt, Idaho. 1,000,000 tons oxidized gold ore stock piled for flotation or cyaniding (no grind needed). On top of Huge copper-lead deposit. Idaho Bul 94. Equipped Ideal. No debts. Mr. Steen, 2608 Warring St., Berkeley 4, Calif. TH 5-7911. Will take good stock.

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1—Conveyor, 36" x 850' center to center, trailing belt type with movable stacker & 36" x 70' center to center stacking conveyor, one 100 HP gearmotor, two 20 HP motors & reducers.
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3—Conveyors, 36" x 50' belt conveyor with 7½ HP gearmotors, steel frames.
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27—Conveyor tables, 42", without hardware, (new) approx. 30'.
22—Conveyor sections, 42" x 30', with idlers.
2—Conveyor sections, 36", with idlers, approx. 30'.
48—Conveyor, 60° troughing idlers.
20—Conveyor, misc. head, tail, and tension pulleys.
2—Conveyor, bridge frames, 30" x 50', less components.
100—Conveyor, 42° troughing idler frames.
159—Conveyeor, troughing idlers, 42".
19—Conveyor, flat return idlers, 42".
115—Conveyor, return idlers, 42".
31—Conveyor, troughing idlers, 36".
21—Conveyor, return idlers, 36" (less frames)
32—Conveyor, troughing idlers, 36".
8—Conveyor, flat return idlers, 30".
670—Conveyor, individual rollers, 36 & 42".
660—Conveyor, tables with idlers, 36".
71—Conveyor, troughing idlers, 42" (new)
20—Conveyor, 30' steel frame sections with 42" idlers.
1356'—Conveyor, 42" Belting, 5 ply, new.
1—Classifier, Dorr Duplex, Rake, 5' x 23'. DFSX, with 5 HP motor.
1—Compressor, IR type 40, with 50 HP motor
1—Crusher, braun Chipmunk, with 2 HP motor
2—Crushers, braun Chipmunk, less motor
1—Crusher, 42" x 36" Birdsboro-Buchanan Jaw with 100 HP motor & starter.
1—Feeder, reciprocating plate feeder, SA, 3' x 5'
1—Feeder, belt, ore, 60" x 10'.
1—Feeder, belt, ore, Deco, 14" x 3'.
1—Feeder, Pan, Jeffrey No. 5
1—Furnace, DFO, double muffle assay, with blower.
1—Furnace, gold melting.
1—Filter, deco pressure, 12" x 12"
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1—Gate, lifting device, electrified, on thickener overflow.
1—Generator set, 50 KW, cat. diesel, (like new).
1—Generator, 2 KVA, Koehler light plant.
1—Hopper, complete belt loading facility with grizzley & Bin, Hydraulically operated, with conveyor reciprocating plate feeder, 10 HP gearmotor.
1—Hoist, monorail, lift, P & H, 2 ton.
1—Hoist, Monorail, lift, 2 HP.
1—Holst, Wright lift, 3 HP
1—Hoist, Electric lift, ½ HP
3—Hoists, Budgit
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2—Hydroseparator, 24' Hardinge with tank and 7½ HP vari-gearmotor drive.

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14—Jigs, Yba, 4 cell, 42" x 42", with gearmotors.
6—Jig heads (extra).
1—Jig, Yba, 2 cell, 42" x 42".
2—Boxes Lining, lintex rubber.
1—Motor, gearmotor—100 HP Westinghouse
57—Motor, misc. motors, and reducers.
1—Mill, Marcy Ball, 5' x 10', with 100 HP motor & controls.
1—Mill, Laboratory Ball, 14" x 14" x 24", with 2 HP motor.
1—Mill, Laboratory Ball, 12" x 18".
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15—Tons Rail, 40-50 lbs.
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1—Pump, viking oil, with motor.
2—Pump, sump, Cascade, with 30 HP motors.
2—Pump, sand, SRL, A.C., 6 inch, with 30 HP motors.
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1—Pump, sand, SRL, A.C. 6 inch, less motor.
5—Pumps, diaphram, Dorreo duplex, 6", less motors.
2—Pumps, diaphram, Dorreo Duplex, 8", less motors.
1—Pump, Yuba, water pump, 10" (bare)
1—Pump, Worthington, Centrifugal, 10 HP.
1—Pump, Fairbanks Morse, Booster pump, 300 HP motor.
1—Pump, Fairbanks Morse, Booster pump, 200 HP motor.
1—Pump, Fairbanks Morse, motor pump, 20 HP motor.
2—Pumps, Byron Jackson, motor pump, one 15 HP one 25 HP
1—Pump, Winthrote Deep well pump, 100 HP motor.
1—Pump, Worthington, Deepwell pump, 100 HP motor, with special slip clutch.
1—Pump, Byron Jackson, Deepwell pump, 30 HP with bowl assay.
2—Pulverizers, Braun motorized, 2 HP motor.
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1—Stacker, stockpiling (incomplete).
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1—Screen, Trommel, 8' x 45', with 100 HP slip ring motor, manganese steel screen sections.
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1—Scale, gold balance, 1/500 mg. Heusser.
1—Scale, Ainsworth balance, Ambytical.
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1—Welder, portable, gasoline, 300 amp.
1—Welder, portable, gasoline, 200 amp.
1—Welder, portable, gasoline 300 amp.
2—Welder, 300-400 amp Lincoln shield ARC, DC
1—Welder, 200 amp, General Elec., D.C.
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1—Lathe, LeBlende, 28" swing, like new.
1—Shaper, 20" Cincinnati.
1—Drill press, upright.
1—Grinder, bench.
1—Cut off saw, swinging type.
1—Band saw.
1—Table saw, 15".
1—Automotive valve grinder.
1—Threader, pipe, 4" cap, 3 HP motor.
1—Air compressor, Devilbiss.
1—Air compressor, DEVilbiss.
1—Air compressor, portable, LeRoi-Rix, 50 HP slip ring elec. motor.
1—Air compressor, Quincy, 20 HP motor.
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1—Vulcanizer, patcher, 12" x 18".
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1—D-8 Cat, with Dozer Blade.
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LOCOMOTIVES—DIESEL
2—1½ Ton Mancha "Little Trammer"

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1—1 Ton General Electric
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2—6 Ton General Electric, type LSBE-2C6
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1—9 Ton Whitcomb
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2—10 Ton Jeffrey, 250 Volts, type MH78
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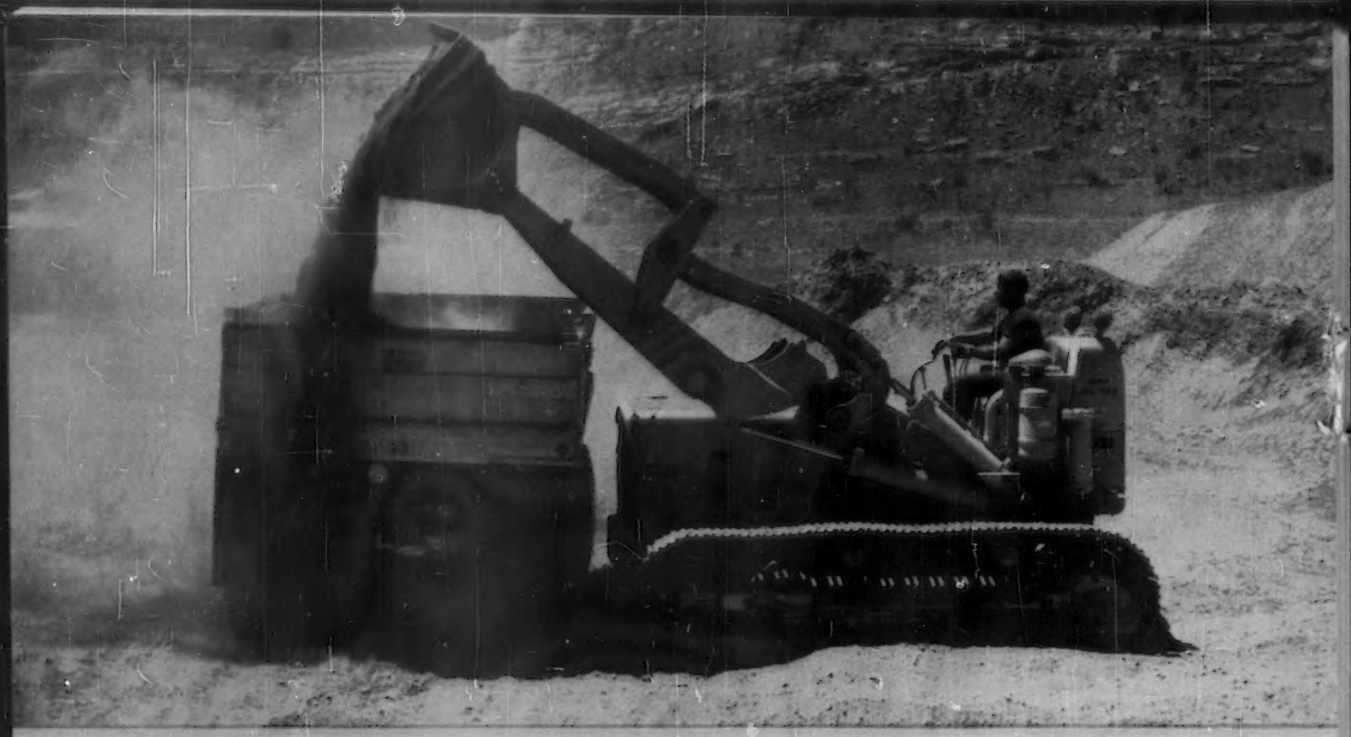

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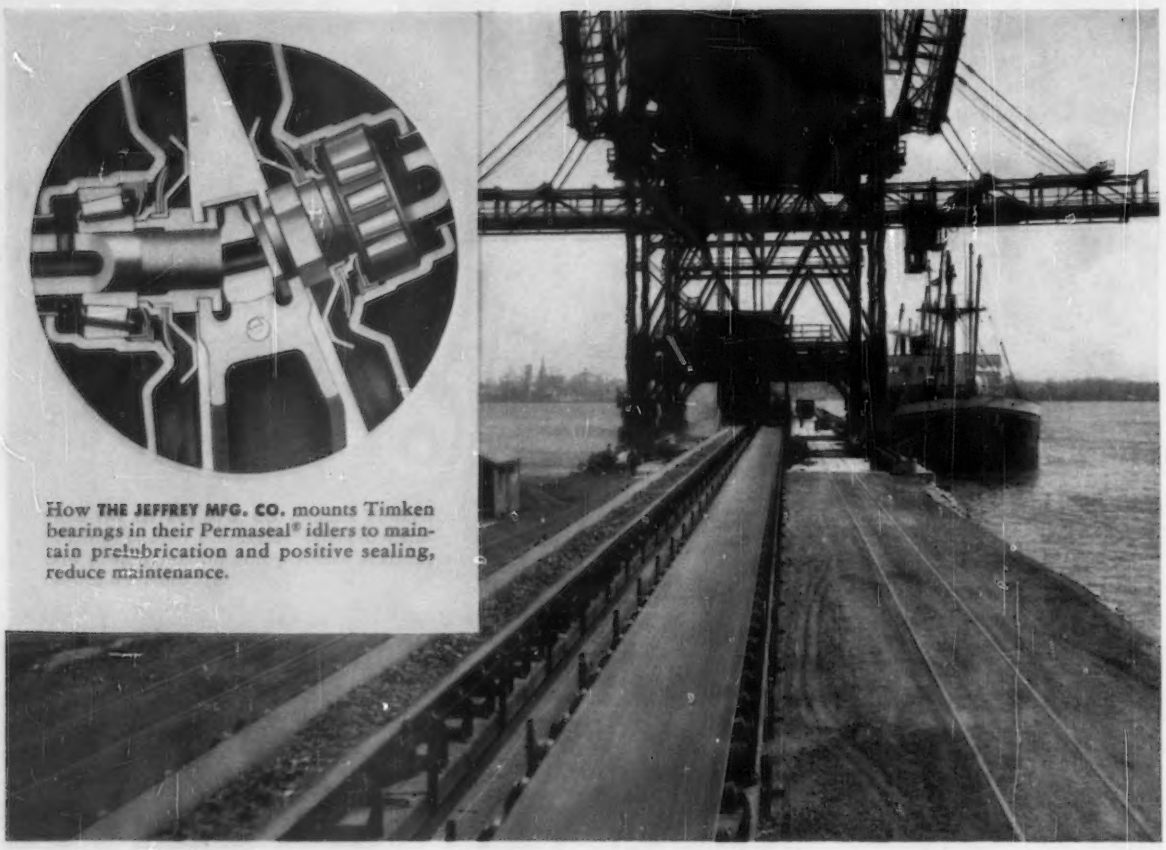

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